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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XX.—FROM THE DIVINE ORACLES TO THE HIGHER CRITICISM.

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I. THE OLDER INTERPRETATION.

THE great sacred books of the world are the most precious of human possessions. They embody the deepest searchings into the most vital problems of humanity in all its stages, the naïve guesses of the world's childhood, the opening conceptions of its youth, the more fully rounded beliefs of its maturity.

These books, no matter how unhistorical in parts and at times, are profoundly true. They mirror the evolution of man's loftiest aspirations, hopes, loves, consolations, and enthusiasms; his hates and fears; his views of his origin and destiny; his theories of his rights and duties; and these not merely in their lights but in their shadows. Therefore it is that they contain the germs of truths most necessary in the evolution of humanity, and give to these germs the environment and sustenance which best insure their growth and strength.

With wide differences in origin and character, all this sacred literature has been developed and has exercised its influence in obedience to certain general laws. First of these in time, if not in importance, is that which governs its origin: in all civilizations we find that the Divine Spirit working in the mind of man shapes his sacred books first of all out of the chaos of myth and legend, and of these books, when life is thus breathed into them, the fittest survive.

So broad and dense is this atmosphere of myth and legend en-

veloping them that it lingers about them after they have been brought forth full-orbed; and, sometimes, from it are even produced secondary mythical and legendary concretions, satellites about these greater orbs of early thought. Of these secondary growths one may be mentioned as showing how rich in myth-making material was the atmosphere which enveloped our own earlier sacred literature.

In the third century before Christ there had been elaborated among the Jewish scholars of Alexandria, then the great center of human thought, a Greek translation of the main books constituting the Old Testament. Nothing could be more natural at that place and time than such a translation; yet the growth of explanatory myth and legend around it was none the less luxuriant. There was indeed a twofold growth. Among the Jews favorable to the new version a legend rose which justified it. This legend in its first stage was to the effect that Ptolemy, then on the Egyptian throne, had, at the request of his chief librarian, sent to Jerusalem for translators; that the high priest Eleazar had sent to the king a most precious copy of the Scriptures from the temple, and six most venerable, devout, and learned scholars from each of the twelve tribes of Israel; that the number of translators thus corresponded with the mysterious seventy-two appellations of God; and that the combined efforts of these seventy-two men produced a marvelously perfect translation.

But, in that atmosphere of myth and marvel, the legend continued to grow, and soon we have it blooming forth yet more gorgeously in the statement that King Ptolemy ordered each of the seventy-two to make by himself a full translation of the entire Old Testament, and shut up each translator in a separate cell on the island of Pharos, secluding him there until the work was done; that the work of each was completed in exactly seventy-two days; and that when, at the end of the seventy-two days, the seventy-two translations were compared, each was found exactly like all the others. This showed clearly Jehovah's *approval.*

But out of all this myth and legend there was also evolved an account of a very different sort. The Jews who remained faithful to the traditions of their race regarded this Greek version as a profanation, and therefore there grew up the legend that on the completion of the work there was darkness over the whole earth during three days. This showed clearly Jehovah's *disapproval.*

These well-known legends, which arose within what—as compared with any previous time—was an exceedingly enlightened period, and which were steadfastly believed by a vast multitude of Jews and Christians for ages, are but single examples among scores which show how inevitably such traditions regarding

sacred books are developed in the earlier stages of civilization, when men explain everything by miracle and nothing by law.*

As the second of these laws governing the evolution of sacred literature may be mentioned that which we have constantly seen so effective in the growth of theological ideas—that to which Comte gave the name of the Law of Wills and Causes. In accordance with this, man attributes to the Supreme Being a physical, intellectual, and moral structure like his own; hence it is that the votary of each of the great world religions ascribes to its sacred books what he considers absolute perfection; he imagines them to be what he himself would give the world were he himself infinitely good, wise, and powerful.

A very simple analogy might indeed show him that even a literature emanating from an all-wise, beneficent, and powerful author might not seem perfect when judged by a human standard; for he has only to look about him in the world to find that the work which he attributes to an all-wise, all-beneficent, and all-powerful Creator is by no means free from evil and wrong.

But this analogy long escapes him, and the exponent of each great religion proves, to his own satisfaction and the edification of his fellows, that their own sacred literature is absolutely accurate in statement, infinitely profound in meaning, and miraculously perfect in form. From these premises also he arrives at the conclusion that his own sacred literature is unique; that no other sacred book can have emanated from a divine source; and that all others claiming to be sacred are impostures.

Still another law governing the evolution of sacred literature in every great world religion is that when the books which compose it are once selected and grouped they come to be regarded as a final creation from which nothing can be taken away, and of which even error in form, if sanctioned by tradition, may not be changed.

The working of this law has recently been seen on a large scale.

A few years since a body of chosen scholars, universally acknowledged to be the most fit for the work, at the call of English-speaking Christendom undertook to revise the authorized English version of the Bible.

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* For the legend regarding the Septuagint, especially as developed by the letters of Pseudo-Aristeas, and for quaint citations from the fathers regarding it, see The History of the Seventy-two Interpretators, from the Greek of Aristeas, translated by Mr. Lewis, London, 1715; also, Clement of Alexandria, in the Ante-Nicene Christian Library, Edinburgh, 1867, p. 448. For interesting summaries showing the growth of the story, see Drummond, Philo-Judæus and the Growth of the Alexandrian Philosophy, London, 1888, vol. i, pp. 231 *et seq.*; also, Rénan, Histoire du Peuple Israel, vol. iv, chap. iv; also, for Philo-Judæus's part in developing the legend, see Rev. Dr. Sanday's Bampton Lectures for 1893, on Inspiration, pp. 86, 87.

Beautiful as was that old version, there was abundant reason for a revision. The progress of biblical scholarship had revealed multitudes of imperfections and not a few gross errors in the work of the early translators, and these, if uncorrected, were sure to bring the sacred volume into discredit.

Nothing could be more reverent than the spirit of the revisers, and the nineteenth century has known few historical events of more significant and touching beauty than the participation in the Holy Communion by all these scholars—prelates, presbyters, ministers, and laymen of churches most widely differing in belief and observance—kneeling side by side at the little altar in Westminster Abbey.

Nor could any work have been more conservative and cautious than theirs; as far as possible they preserved the old matter and form with scrupulous care.

Yet their work was no sooner done than it was bitterly attacked and widely condemned; to this day it is largely regarded with dislike. In Great Britain, in America, in Australia, the old version, with its glaring misconceptions, mistranslations, and interpolations, is still read in preference to the new; the great body of English-speaking Christians clearly preferring the accustomed form of words given by the seventeenth-century translators, rather than a nearer approach to the exact teaching of the Holy Ghost.

Still another law is that when once a group of sacred books has been evolved—even though the group really be a great library of most dissimilar works, ranging in matter from the hundredth Psalm to the Song of Songs, and in manner from the sublimity of Isaiah to the offhand story-telling of Jonah—all come to be thought one inseparable mass of interpenetrating parts; every statement in each fitting exactly and miraculously into each statement in every other; and each and every one, and all together, literally true to fact, and at the same time full of hidden meanings.

The working of these and other laws governing the evolution of sacred literature is very clearly seen in the great rabbinical schools which flourished at Jerusalem, Tiberias, and elsewhere, after the return of the Jews from the Babylonian captivity, and especially as we approach the time of Christ. These schools developed a subtlety in the study of the Old Testament which seems almost preternatural. The resultant system was mainly a jugglery with words, phrases, and numbers, which finally became a "sacred science," with various recognized departments, in which interpretation was carried on sometimes by attaching a numerical value to letters; sometimes by interchange of letters from differently arranged alphabets; sometimes by the making of new texts out of the initial letters of the old; and with ever-increasing subtlety.

Such efforts as these culminated fitly in the rabbinical declaration that each passage in the law has seventy distinct meanings, and that God himself gives three hours every day to their study.

After this the Jewish world was prepared for anything, and it does not surprise us to find such discoveries in the domain of ethical culture as the doctrine that for inflicting the forty stripes save one upon those who broke the law the lash should be braided of ox-hide and ass-hide; and, as warrant for this construction of the lash, the text, "The ox knoweth his owner, and the ass his master's crib, but Israel doth not know"; and, as the logic connecting text and lash, the statement that Jehovah evidently intended to command that "the men who know not shall be beaten by those animals whose knowledge shames them."

By such methods also were revealed such historical treasures as that Og, King of Bashan, escaped the deluge by wading after Noah's ark.

There were, indeed, noble exceptions to this kind of teaching. It can not be forgotten that Rabbi Hillel formulated the golden rule, which had before him been given to the extreme Orient by Confucius, and which afterward received a yet more beautiful emphasis from Jesus of Nazareth; but the seven rules of interpretation laid down by Hillel were multiplied and refined by men like Rabbi Ismael and Rabbi Eleazar until they justified every absurd subtlety.*

An eminent scholar has said that while the letter of Scripture became ossified in Palestine, it became volatilized at Alexandria; and the truth of this remark was proved by the Alexandrian Jewish theologians just before the beginning of our era.

This, too, was in obedience to a law of development, which is that, when literal interpretation clashes with increasing knowledge or with progress in moral feeling, theologians take refuge in mystic meanings—a law which we see working in all great religions, from the Brahmans finding hidden senses in the Vedas to Plato and the Stoics finding them in the Greek myths; and from the Sofi reading new meanings into the Koran, to eminent Christian divines of the nineteenth century giving a non-natural sense to some of the plainest statements in the Bible.

The great early master in this evolution was Philo; by him came as never before the use of allegory. The garden of Eden

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* For a multitude of amusing examples of rabbinical interpretations, see an article in Blackwood's Magazine for November, 1882; for a more general discussion, see Archdeacon Farrar's History of Interpretation, lect. i and ii, and Rev. Prof. H. P. Smith's Inspiration and Inerrancy, Cincinnati, 1893, especially chap. iv; also Reuss, History of the New Testament, English translation, pp. 527, 528.

thus becomes virtue; Abraham's country and kindred, from which he was commanded to depart, the human body and its members; the five cities of Sodom, the five senses; the Euphrates, correction of manners. By Philo and his compeers even the most insignificant words and phrases, and those especially, were held to conceal the most precious meanings.

A perfectly natural and logical result of this view was reached when Philo, saturated as he was with Greek culture and nourished on pious traditions of the utterances at Delphi and Dodona, spoke reverently of the Jewish Scriptures as "oracles." Oracles they became, as oracles they appeared in the early history of the Christian Church, and oracles they remained for centuries: eternal life or death, infinite happiness or agony, as well as ordinary justice in this world, being made to depend on certain interpretations of a long series of recondite or doubtful utterances —interpretations frequently given by men who might have been prophets and apostles, but who had become simply oracle-mongers.

Pressing the oracle into the service of science, Philo became the forerunner of that long series of theologians who, from Augustine and Cosmas to Mr. Gladstone, have attempted to extract from scriptural myth and legend profound contributions to natural science. Thus he taught that the golden candlesticks in the tabernacle symbolized the planets, the high priest's robe the universe, and the bells upon it the harmony of earth and water—whatever that may mean. So Cosmas taught, a thousand years later, that the table of showbread in the tabernacle showed forth the form and construction of the world; and Mr. Gladstone hinted, more than a thousand years later still, that Neptune's trident had a mysterious connection with the Christian doctrine of the Trinity.*

These methods, in spite of the resistance of Tertullian and Irenæus, were transmitted to the early Church; as applied to the

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* For Philo Judæus, see Yonge's translation, Bohn's edition; see also Sanday on Inspiration, pp. 78–85. For admirable general remarks on this period in the history of exegesis, see Bartlett, Bampton Lectures, 1888, p. 29. For efforts in general to save the credit of myths by allegorical interpretation, and for those of Philo in particular, see Drummond, Philo-Judæus, London, 1888, vol. i, pp. 18, 19 and notes. For interesting samples of Alexandrian exegesis and for Philo's application of the term "oracle" to the Jewish Scriptures, see Farrar, History of Interpretation, p. 147 and note. For his discovery of symbols of the universe in the furniture of the tabernacle, see Drummond, as above, vol. i, pp. 269 *et seq.* For the general subject, admirably discussed from a historical point of view, see the Rev. Edwin Hatch, D. D., The Influence of Greek Ideas and Usages upon the Christian Church, Hibbert Lectures for 1888, chap. iii. For Cosmas, see my chapters on Geography and Astronomy. For Mr. Gladstone's view of the connection between Neptune's trident and the doctrine of the Trinity, see his Juventus Mundi.

Old Testament, they had appeared at times in the New; in the work of the early fathers they bloomed forth luxuriantly.

Justin Martyr and Clement of Alexandria vigorously extended them. Typical of Justin's method is his finding, in a very simple reference by Isaiah to Damascus, Samaria, and Assyria, a clear prophecy of the three wise men of the east who brought gifts to the infant Saviour, and in the bells on the priest's robe a prefiguration of the twelve apostles. Any difficulty arising from the fact that the number of bells is not specified in Scripture, Justin overcame by insisting that David referred to this prefiguration in the nineteenth Psalm: "Their sound is gone forth through all the earth and their words to the end of the world."

Working in this vein, Clement of Alexandria found in the form, dimensions, and color of the Jewish tabernacle a whole wealth of interpretation—the altar of incense representing the earth placed at the center of the universe, the high priest's robe the visible world, the jewels on the priest's robe the zodiac, and Abraham's three days' journey to Mount Moriah the three stages of the soul in its progress toward the knowledge of God. Interpreting the New Testament, he lessened any difficulties involved in the miracle of the barley loaves and fishes by suggesting that what this really means is that Jesus gave mankind a preparatory training for the gospel by means of the law and philosophy, because, as he says, barley, like the law, ripens sooner than wheat, which represents the gospel, and because, just as fishes grow in the waves of the ocean, so philosophy grew in the waves of the Gentile world.

Out of reasonings like these, those who followed, especially Cosmas, developed, as we have seen, a complete theological science of geography and astronomy.*

But the instrument in exegesis which was used with most cogent force was the occult significance of certain numbers. The Chaldean and Egyptian researches of our own time have revealed the great source of this line of thought; the speculations of Plato upon it are well known; but among the Jews and in the early Church it grew into something far beyond the wildest imaginings of the priests of Memphis and Babylon.

Philo had found for the elucidation of Scripture especially deep meanings in the numbers 4, 6, and 7; but other interpreters

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* For Justin, see the Dialogue with Trypho, chaps. xlii, lxxvi, and lxxxiii. For Clement of Alexandria, see his Miscellanies, Book V, chaps. vi and xi, and Book VII, chap. xvi, and especially Hatch, Hibbert Lectures, as above, pp. 76, 77.

As to the loose views of the canon held by these two fathers and others of their time see Ladd, Doctrine of the Sacred Scriptures, vol. ii, pp. 86, 88; also Diestel, Geschichte des alten Testaments.

soon surpassed him. At the very outset this occult power was used in ascertaining the canonical books of Scripture. Josephus argued that, since there were twenty-two letters in the Hebrew alphabet, there must be twenty-two sacred books in the Old Testament; other Jewish authorities thought that there should be twenty-four books, on account of the twenty-four watches in the temple. St. Jerome wavered between the argument based upon the twenty-two letters in the Hebrew alphabet and that suggested by the twenty-four elders in the Apocalypse. Hilary of Poitiers argued that there must be twenty-four books, on account of the twenty-four letters in the Greek alphabet. Origen found an argument for the existence of exactly four gospels in the existence of just four elements. Irenæus insisted that there could be neither more nor fewer than four gospels, since the earth has four quarters, the air four winds, and the cherubim four faces; and he denounced those who declined to accept this reasoning as "vain, ignorant, and audacious." *

But during the first half of the third century came one who exercised a still stronger influence in this direction—a great man who, while rendering precious services, did more than any other to fasten upon the Church a system which has been one of its heaviest burdens for more than sixteen hundred years: this was Origen. Yet his purpose was noble and his work based on profound thought. He had to meet the leading philosophers of the pagan world and to reply to their arguments against the Old Testament, and especially to their taunts against its imputation of human form, limitations, passions, weaknesses, and even immoralities to the Almighty.

Starting with a mistaken translation of a verse in the book of Proverbs, Origen presented as a basis for his main structure the idea of a threefold sense of Scripture: the literal, the moral, and the mystic—corresponding to the Platonic conception of the threefold nature of man. As results of this we have such masterpieces as his proof, from the fifth verse of chapter xxv of Job, that the stars are living beings, and from the well-known passage in the nineteenth chapter of St. Matthew his warrant for self-mutilation. But his great triumphs were in the allegorical method. By its use the Bible was speedily made an oracle indeed, or, rather, a book of riddles. A list of kings in the Old Testament thus be-

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* For Jerome and Origen, see notes on pages following. For Irenæus, see Irenæus adversus Heres., lib. iii, cap. xi, § 8. For the general subject, see Sanday on Inspiration, p. 115; also Farrar and H. P. Smith as above. For a recent very full and very curious statement from a Roman Catholic authority regarding views cherished in the older Church as to the symbolism of numbers, see Detzel, Christliche Iconographie, Freiburg im Breisgau, 1894, Band i, Einleitung, p. 4.

comes an enumeration of sins; the waterpots of stone, "containing two or three firkins apiece," at the marriage of Cana, signify the literal, moral, and spiritual sense of Scripture; the ass upon which the Saviour rode on his triumphal entry into Jerusalem becomes the Old Testament, the foal the New Testament, and the two apostles who went to loose them the moral and mystical senses; blind Bartimeus, throwing off his coat while hastening to Jesus, opens a whole treasury of oracular meanings.

The genius and power of Origen made a great impression on the strong thinkers who followed him. St. Jerome called him "the greatest master in the Church since the apostles," and Athanasius was hardly less emphatic.

The structure thus begun was continued by leading theologians during the centuries following. St. Hilary of Poitiers—"the Athanasius of Gaul"—produced some wonderful results of this method; but St. Jerome, inspired by the example of the man whom he so greatly admired, went beyond him. A triumph of his exegesis is seen in his statement that the Shunamite woman, who was selected to cherish David in his old age, signified heavenly wisdom.

The great mind of St. Augustine was drawn largely into this kind of creation, and nothing marks more clearly the vast change which had come over the world than the fact that this greatest of the early Christian thinkers turned from the broader paths opened by Plato and Aristotle into that opened by Clement of Alexandria.

In the mystic power of numbers to reveal the sense of Scripture Augustine found especial delight. He tells us that there is deep meaning in sundry scriptural uses of the number forty, and especially as the number of days required for fasting. Forty, he reminds us, is four times ten. Now, four is the number especially representing time, the day and the year being each divided into four parts; while ten, being made up of three and seven, represents knowledge of the Creator and creature, three referring to the three persons in the triune Creator, and seven referring to the three elements, heart, soul, and mind, taken in connection with the four elements, fire, air, earth, and water, which go to make up the creature. Therefore this number ten, representing knowledge, being multiplied by four, representing time, admonishes us to live during time according to knowledge—that is, to fast for forty days.

Referring to such misty methods as these, which lead the reader to ask himself whether he is sleeping or waking, St. Augustine remarks that "ignorance of numbers prevents us from understanding such things in Scripture." But perhaps the most amazing example is to be seen in his notes on the hundred and fifty and

three fishes which, according to St. John's Gospel, were caught by St. Peter and the other apostles. Some points in his long development of this subject may be selected to show what the older theological method can be made to do for a great mind. He tells us that the hundred and fifty and three fishes embody a great mystery; that the number ten, evidently as the number of the commandments, indicates the law; but, as the law without the spirit only kills, we must add the seven gifts of the spirit, and we thus have the number seventeen, which signifies the old and new dispensations; then, if we add together every several number which seventeen contains from one to seventeen inclusive, the result is a hundred and fifty and three—the number of the fishes.

With this sort of reasoning he finds profound meanings in the number of furlongs mentioned in the sixth chapter of St. John. Referring to the fact that the disciples had rowed about "twenty-five or thirty furlongs," he declares that "twenty-five typifies the law, because it is five times five, but the law was imperfect before the gospel came; now perfection is comprised in six, since God in six days perfected the world, hence five is multiplied by six that the law may be perfected by the gospel, and six times five is thirty."

But Augustine's exploits in exegesis were not all based on numerals; he is sometimes equally profound in other modes. Thus he tells us that the condemnation of the serpent to eat dust typifies the sin of curiosity, since in eating dust he "penetrates the obscure and shadowy"; and that Noah's ark was "pitched within and without with pitch" to show the safety of the Church from the leaking in of heresy.

Still another exploit—one at which the Church might well have stood aghast—was his statement that the drunkenness of Noah prefigured the suffering and death of Christ. It is but just to say that he was not the original author of this interpretation; it had been presented long before by St. Cyprian. But this was far from Augustine's worst. Perhaps no interpretation of Scripture has ever led to more cruel and persistent oppression, torture, and bloodshed than his reading into one of the most beautiful parables of Jesus of Nazareth—into the words "compel them to come in"—a warrant for religious persecution: of all unintentional blasphemies since the world began possibly the most appalling.

Another strong man follows to fasten these methods on the Church: St. Gregory the Great. In his renowned work on the book of Job, the Magna Moralia, given to the world at the end of the sixth century, he lays great stress on the deep mystical meanings of the statement that Job had seven sons. He thinks the seven sons typify the twelve apostles, for "the apostles were

selected through the sevenfold grace of the Spirit; moreover, twelve is produced from seven—that is, the two parts of seven, four and three, when multiplied together give twelve." He also finds deep significance in the number of the apostles; this number being evidently determined by a multiplication of the number of persons in the Trinity by the number of quarters of the globe. Still, to do him justice, it must be said that in some parts of his exegesis the strong sense which was one of his most striking characteristics crops out in a way very refreshing. Thus, referring to a passage in the first chapter of Job, regarding the oxen which were plowing and the asses which were feeding beside them, he tells us pithily that these typify two classes of Christians: the oxen, the energetic Christians who do the work of the Church; the asses, the lazy Christians who merely feed.*

Thus began the vast theological structure of oracular interpretation applied to the Bible. As we have seen, the men who prepared the ground for it were the rabbis of Palestine and the Hellenized Jews of Alexandria; and the four great men who laid its foundation courses were Origen, St. Augustine, St. Jerome, and St. Gregory.

During the ten centuries following the last of these men, this structure continued to rise steadily above the plain meanings of Scripture. The Christian world rejoiced in it, and the few great thinkers who dared bring the truth to bear upon it were rejected. It did indeed seem at one period in the early Church that a better system might be developed. The School of Antioch, especially as represented by Chrysostom, appeared likely to lead in this better way, but the dominant forces were too strong; the passion for myth and marvel prevailed over the love of real knowledge, and the reasonings of Chrysostom and his compeers were neglected.†

In the ninth century came another effort to present the claims of right reason. The first man prominent in this was St.

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* For Origen, see the De Principiis, Book IV, chaps. i–vii *et seq.*, Crombie's translation; also the Contra Celsum, vi, 70; vii, 20, etc.; also various citations in Farrar. For Hilary, see his Tractatus super Psalmos, cap. ix, li, etc., in Migne, tom. ix, and De Trinitate, lib. ii, cap. ii. For Jerome's interpretation of the text relating to the Shunamite woman, see Epist. liii, in Migne, tom. xxii, pp. 527, 528. For Augustine's use of numbers, see the De Doctrina Christiana, lib. ii, cap. xvi, and for the explanation of the draught of fishes, see Augustine in Johan. Evangel., Tractat. cxxii, and on the twenty-five-to thirty furlongs, ibid., xxv, sect. 6; and for the significance of the serpent eating dust, ibid., ii, 18. For the view that the drunkenness of Noah prefigured the suffering of Christ, as held by SS. Cyprian and Augustine, see Farrar, as above, pp. 181, 238. For St. Gregory, see the Magna Moralia, lib. i, cap. xiv.

† For the work of the School of Antioch, and especially of Chrysostom, see the eloquent tribute to it by Farrar, as above.

Agobard, Bishop of Lyons, whom an eminent historian has well called the clearest head of his time. With the same insight which penetrated the fallacies and follies of image worship, belief in witchcraft, persecution, the ordeal, and the judicial duel, he saw the futility of this vast fabric of interpretation, protested against the idea that the Divine Spirit extended its inspiration to the mere words of Scripture, and asked a question which has resounded through every generation since: "If you once begin such a system, who can measure the absurdity which will follow?"

During the same century another opponent of this dominant system appeared: John Scotus Erigena. He contended that "reason and authority come alike from the one source of Divine Wisdom"; that the fathers, great as their authority is, often contradict each other; and that, in last resort, reason must be called in to decide between them.

But the evolution of unreason continued: Agobard was unheeded, and Erigena placed under the ban by two councils, his work being condemned by a synod as a "*Commentum Diaboli.*" Four centuries later Honorius III ordered it to be burned, as "teeming with the venom of heretical depravity"; and finally, after eight centuries, Pope Gregory XIII placed it on the Index, where it remains to this day. Nor did Abélard, who, three centuries after Agobard and Erigena, made an attempt in some respects like theirs, have any better success: his fate at the hands of St. Bernard and the Council of Sens the world knows by heart. Far more consonant with the spirit of the universal Church was the teaching in the twelfth century of the great Hugo of St. Victor, conveyed in these ominous words: "Learn first what is to be believed" (*Disce primo quod credendum est*), meaning thereby that one should first accept doctrines, and then find texts to confirm them.

These principles being dominant, the accretions to the enormous fabric of interpretation went steadily on. Typical is the fact that the Venerable Bede contributed to it the doctrine that, in the text mentioning Elkanah and his two wives, Elkanah means Christ and the two wives the Synagogue and the Church; even such men as Alfred the Great and St. Thomas Aquinas were added to the forces at work in building above the sacred books this prodigious mass of sophistry.

Perhaps nothing shows more clearly the tenacity of the old system of interpretation than the sermons of Savonarola. During the last decade of the fifteenth century, just at the close of the mediæval period, he was engaged in a life-and-death struggle at Florence. No man ever preached more powerfully the Gospel of Righteousness; none ever laid more stress on conduct; even Luther was not more zealous for reform or more careless of tra-

ditionalism; and yet we find the great Florentine apostle and martyr absolutely tied fast to the old system of allegorical interpretation. The autograph notes of his sermons, still preserved in his cell at San Marco, show this abundantly. Thus we find him attaching to the creation of grasses and plants on the third day an allegorical connection with the "multitude of the elect" and with the "sound doctrines of the Church"; and to the creation of land animals on the sixth day a similar relation to "the Jewish people" and to "Christians given up to things earthly."*

The revival of learning in the fifteenth century seemed likely to undermine the older structure.

Then it was that Lorenzo Valla brought to bear on biblical research, for the first time, the spirit of modern criticism. By truly scientific methods he proved the famous Letter of Christ to Abgarus a forgery; the Donation of Constantine, one of the great foundations of the ecclesiastical power in temporal things, a fraud; and the creed attributed to the apostles a creation which post-dated them by several centuries. Of even more permanent influence was his work upon the New Testament, in which he initiated the modern method of comparing manuscripts to find what the sacred text really is. At an earlier or later period he would doubtless have paid for his temerity with his life; fortunately, just at that time, the ruling pontiff and his contemporaries cared much for literature and little for orthodoxy, and from their palaces he could bid defiance to the Inquisition.

While Valla thus initiated biblical criticism south of the Alps, a much greater man began a more fruitful work in northern Europe. Erasmus, with his edition of the New Testament, stands at the source of that great stream of modern research and thought which is doing so much to undermine and dissolve away the vast fabric of patristic and scholastic interpretation.

Yet his efforts to purify the scriptural text seemed at first to encounter insurmountable difficulties, and one of these may stimulate reflection. He had found, what some others had found before him, that the famous verse in the first chapter of the First

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* For Agobard, see the Liber adversus Fredigisum, cap. xii; also Reuter's Relig. Aufklärung im Mittelalter, i, 24; also Poole, Illustrations of the History of Mediæval Thought, London, 1884, pp. 38 *et seq.* For Erigena, see his De Divisione Naturæ, lib. iv, cap. v, also i, cap. lxvi–lxxi, and for general account see Ueberweg, History of Philosophy, New York, 1871, vol. i, pp. 358 *et seq.*, and for the treatment of his work by the Church, see the edition of the Index under Leo XIII, 1881. For Abélard, see the Sic et Non, Prologue, Migne, tom. clxxviii, and, on the general subject, Milman, Latin Christianity, vol. iii, pp. 371–377. For Hugo of St. Victor, see Erudit. Didask., lib. vii, vi, 4, in Migne, clxxvi. For Savonarola's interpretations, see various references to his preaching in Villari's Life of Savonarola, English translation, London, 1890, and especially the exceedingly interesting table in the appendix to vol. i, chap. vii.

General Epistle of St. John, regarding the "three witnesses," was an interpolation. Careful research through all the really important early manuscripts showed that it appeared in none of them. Even after the Bible had been corrected in the eleventh and twelfth centuries by Lanfranc, Archbishop of Canterbury, and by Nicholas, cardinal and librarian of the Roman Church, "in accordance with the orthodox faith," the passage was still wanting in the more authoritative Latin manuscripts. There was not the slightest tenable ground for believing in the authenticity of the text; on the contrary, it has been demonstrated that, after a universal silence of the orthodox fathers of the Church, of the ancient versions of the Scriptures, and of all really important manuscripts, the verse first appeared in a Confession of Faith drawn up by an obscure zealot toward the end of the fifth century. In a very mild exercise, then, of critical judgment, Erasmus omitted this text from the first two editions of his Greek Testament as evidently spurious. A storm arose at once. In England, Lee, afterward Archbishop of York; in Spain, Stunica, one of the editors of the Complutensian Polyglot; and in France, Budé, Syndic of the Sorbonne, together with a vast army of monks in England and on the Continent, attacked him ferociously. He was condemned by the University of Paris, and various propositions of his were declared to be heretical and impious. Fortunately, the worst persecutors could not reach him; otherwise they might have treated him as they treated his disciple, Berquin, whom they burned at Paris in 1529.

The fate of this spurious text throws light into the workings of human nature in its relations to sacred literature. Although Luther omitted it from his translation of the New Testament, and kept it out of every copy published during his lifetime, and although at a later period the most eminent Christian scholars showed that it had no right to a place in the Bible, it was, after Luther's death, replaced in the German translation, and has been incorporated into all important editions of it, save one, since the beginning of the seventeenth century. So essential was it found in maintaining the dominant theology that, despite the fact that Sir Isaac Newton, Richard Porson, the nineteenth-century revisers, and all other eminent authorities have rejected it, the Anglican Church still retains it in its Lectionary, and the Scotch Church continues to use it in the Westminster Catechism, as a main support of the doctrine of the Trinity.

Nor were other new truths, presented by Erasmus, better received. His statement that "some of the Epistles ascribed to St. Paul are certainly not his," which is to-day universally acknowledged as a truism, also aroused a storm. For generations, then, his work seemed vain.

On the coming in of the Reformation the great structure of belief in the literal and historical correctness of every statement in the Scriptures, in the profound allegorical meanings of the simplest texts, and even in the divine origin of the vowel punctuation, towered more loftily and grew more rapidly than ever before. The reformers, having cast off the authority of the Pope and of the universal Church, fell back all the more upon the infallibility of the sacred books. The attitude of Luther toward this great subject was characteristic. As a rule he adhered tenaciously to the literal interpretation of the Scriptures; his argument against Copernicus is a fair example of his reasoning in this respect; but, with the strong good sense which characterized him, he from time to time broke away from the received belief. Thus, he took the liberty of understanding certain passages in the Old Testament in a different sense from that given them by the New Testament, and declared St. Paul's allegorical use of the story of Sarah and Hagar "too unsound to stand the test." He also emphatically denied that the Epistle to the Hebrews was written by St. Paul, and he did this in the exercise of a critical judgment upon internal evidence. His utterance as to the Epistle of St. James became famous. He announced to the Church: "I do not esteem this an apostolic epistle; I will not have it in my Bible among the canonical books," and he summed up his opinion in his well-known allusion to it as "an epistle of straw."

Emboldened by him, the gentle spirit of Melanchthon, while usually taking the Bible very literally, at times revolted; but this was not due to any want of loyalty to the old method of interpretation: whenever the wildest and most absurd system of exegesis seemed necessary to support any part of the reformed doctrine, Luther and Melanchthon unflinchingly developed it. Both of them held firmly to the old dictum of Hugo of St. Victor, which, as we have seen, was virtually that one must first accept the doctrine, and then find scriptural warrant for it. Very striking examples of this were afforded in the interpretation by Luther and Melanchthon of certain alleged marvels of their time, and one out of several of these may be taken as typical of their methods.

In 1523 Luther and Melanchthon jointly published a work under the title Der Papstesel, interpreting the significance of a strange, ass-like monster which, according to a popular story, had been found floating in the Tiber some time before. This book was illustrated by startling pictures, and both text and pictures were devoted to proving that this monster was "a sign from God," indicating the doom of the papacy. This treatise by the two great founders of German Protestantism pointed out that the ass's head signified the Pope himself, "for," said they, "as well as an ass's head is suited to a human body, so well is the Pope suited to be

head over the Church." This argument was clinched by a reference to Exodus. The right hand of the monster, said to be like an elephant's foot, they made to signify the spiritual rule of the Pope, since "with it he tramples upon all the weak": this they proved from the book of Daniel and the Second Epistle to Timothy. The monster's left hand, which was like the hand of a man, they declared to mean the Pope's secular rule, and they found passages to support this view in Daniel and St. Luke. The right foot, which was like the foot of an ox, they declared to typify the servants of the spiritual power, and proved this by a citation from St. Matthew. The left foot, like a griffin's claw, they made to typify the servants of the temporal power of the Pope, and the highly developed breasts and various other members, cardinals, bishops, priests, and monks, "whose life is eating, drinking, and unchastity": to prove this they cited passages from Second Timothy and Philippians. The alleged fish-scales on the arms, legs, and neck of the monster they made to typify secular princes and lords, "since," as they said, "in St. Matthew and Job the sea typifies the world, and fishes men." The old man's head at the base of the monster's spine they interpreted to mean "the abolition and end of the papacy," and proved this from Hebrews and Daniel. The dragon which opens his mouth in the rear and vomits fire, "refers to the terrible, virulent bulls and books which the Pope and his minions are now vomiting forth into the world." The two great reformers then went on to insist that, since this monster was found at Rome, it could refer to no person but the Pope, "for," they said, "God always sends his signs in the places where their meaning applies." Finally, they assured the world that the monster in general clearly signified that the papacy was then near its end. To this development of interpretation Luther and Melanchthon especially devoted themselves; the latter by revising this exposition of the prodigy, and the former by making additions to a new edition.

So great was the success of this kind of interpretation that Luther, hearing that a monstrous calf had been found at Freiburg, published a treatise upon it, showing, by citations from the books of Exodus, Kings, the Psalms, Isaiah, and Daniel, and the Gospel of St. John, that this new monster was the especial work of the devil, but full of meaning in regard to the questions at issue between the reformers and the older Church.

The other great branch of the reformed Church appeared for a time to establish a better system. Calvin's strong logic seemed at one period likely to tear his adherents away from the older method; but the evolution of scholasticism continued, and the great influence of the German reformers prevailed. At every theological center came an amazing development of interpretation. Eminent Lutheran divines in the seventeenth century, like Ger-

hard, Calovius, Cocceius, and multitudes of others, wrote scores of quartos to further this system, and the other branch of the Protestant Church emulated their example. The pregnant dictum of St. Augustine—"Greater is the authority of Scripture than all human capacity"—was steadily insisted upon, and toward the close of the seventeenth century Voetius, the renowned professor at Utrecht, declared, "Not a word is contained in the Holy Scriptures which is not in the strictest sense inspired, the very punctuation not excepted." But unfortunately it was very difficult to find what the "authority of Scripture" really was. To the greater number of Protestant ecclesiastics it meant the authority of any meaning in the text which they had the wit to invent and the power to enforce.

To increase this vast confusion came, in the older branch of the Church, the idea of the divine inspiration of St. Jerome's Latin translation of the Bible—the Vulgate. It was insisted by leading Catholic authorities that this was as completely a product of divine inspiration as was the Hebrew original. Strong men arose to insist even that, where the Hebrew and the Latin differed, the Hebrew should be altered to fit Jerome's mistranslation, as the latter, having been made under the new dispensation, must be better than that made under the old. Even so great a man as Cardinal Bellarmine exerted himself in vain against this new tide of unreason.*

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* For Valla, see various sources already named; and, for an especially interesting account, Symonds's Renaissance in Italy, the Revival of Learning, pp. 260–269; and, for the opinion of the best contemporary judge, see Erasmi Opera, Leyden, 1703, tom. iii, p. 98. For Erasmus and his opponents, see Life of Erasmus, by Butler, London, 1825, pp. 179–182; but especially, for the general subject, Bishop Creighton's History of the Papacy during the Reformation.

For the attack by Budé and the Sorbonne and the burning of Berquin, see Drummond, Life and Character of Erasmus, vol. ii, pp. 220–223; also pp. 230–239. As to the text of the Three Witnesses, see Gibbon, Decline and Fall of the Roman Empire, chap. xxxvii, notes 116–118; also Dean Milman's note thereupon. For a full and learned statement of the evidence against the verse, see Porson's Letters to Travis, London, 1790, in which an elaborate discussion of all the MSS. is given. See also Jowett in Essays and Reviews, p. 307. For a very full and impartial history of the long controversy over this passage, see Charles Butler's Horæ Biblicæ, reprinted in Jared Sparks's Theological Essays and Tracts, vol. ii. For Luther's ideas of interpretation, see his Sämmtliche Schriften, Walch edition, vol. i, p. 1199, vol. ii, p. 1758, vol. viii, p. 2140; for some of his more free views, vol. xiv, p. 472, vol. vi, p. 121, vol. xi, p. 1448, vol. xi, p. 1089; also, Tholuck, Doctrine of Inspiration, Boston, 1867, citing the Colloquia, Frankfort, 1571, vol. ii, p. 102; also, the Vorreden zu der deutschen Bibelübersetzung, in Walch's edition, as above, vol. xiv, especially pp. 94, 98, and 146–150. As to Melanchthon, see especially his Loci Communes, 1521; and, as to the enormous growth of commentaries in the generations immediately following, see Charles Beard, Hibbert Lectures for 1883, on the Reformation, especially the admirable chapter on Protestant Scholasticism; also Archdeacon Farrar, History of Interpretation. For the Papstesel, etc., see Luther's Sämmtliche Schriften, edit. Walch, vol. xiv, pp. 2403 *et seq.*; also Melanchthon's

Nor was a fanatical adhesion to the mere letter of the sacred text confined to western Europe. About the middle of the seventeenth century, in the reign of Alexis, father of Peter the Great, Nikon, Patriarch of the Russian Greek Church, attempted to correct the Slavonic Scriptures and service-books. They were full of interpolations due to ignorance, carelessness, or zeal, and in order to remedy this state of the texts Nikon procured a number of the best Greek and Slavonic manuscripts, set the leading and most devout scholars he could find at work upon them, and caused Russian Church councils in 1655 and 1666 to promulgate the books thus corrected.

Straightway great masses of the people, led by monks and parish priests, rose in revolt. The fact that the revisers had written in the New Testament the name of Jesus correctly, instead of following the old wrong orthography, aroused the wildest fanaticism. The monks of the great convent of Solovetsk, when the new books were sent them, cried in terror: "Woe, woe! what have you done with the Son of God?" They then shut their gates, defying patriarch, council, and Czar, until, after a struggle lasting seven years, their monastery was besieged and taken by an imperial army. Hence arose the great sect of the "Old Believers," lasting to this day, and fanatically devoted to the corrupt readings of the old text.*

Opera, edit. Bretschneider, vol. xx, pp. 665 *et seq.* In the White Library of Cornell University will be found an original edition of the book with engravings of the monster. For the Mönchkalb, see Luther's works as above, vol. xix, pp. 2416 *et seq.* For the spirit of Calvin in interpretation, see Farrar, and especially H. P. Smith, D. D., Inspiration and Inerrancy, chap. iv, and the very brilliant essay forming chap. iii of the same work, by L. J. Evans, pp. 66 and 67, note. For the attitude of the older Church toward the Vulgate, see Pallavicini, Histoire du Concile de Trente, Montrouge, 1844, tom. i, pp. 19, 20; but especially Symonds, The Catholic Reaction, vol. i, pp. 226 *et seq.* As to a demand for a revision of the Hebrew Bible to correct its differences from the Vulgate, see Emanuel Deutsch's Literary Remains, New York, 1874, p. 9. For the work and spirit of Calovius and other commentators immediately following the Reformation, see Farrar, as above; also Beard, Schaff, and Hertzog, Geschichte des alten Testaments in der Christlichen Kirche, pp. 527 *et seq.* As to extreme views of Voetius and others, see Tholuck, as above.

* The present writer, visiting Moscow in the spring of 1894, was presented by Count Leo Tolstoi to one of the most eminent and influential members of the sect of "Old Believers," which dates from the reform of Nikon. Nothing could exceed the fervor with which this venerable man, standing in the chapel of his superb villa, expatiated upon the horrors of making the sign of the cross with three fingers instead of with two. His argument was that the *two* fingers, as used by the "Old Believers," typify the divine and human nature of our Lord, and hence that the use of them is strictly correct; whereas, signing with *three* fingers, representing the blessed Trinity, is "virtually to crucify all three persons of the Godhead afresh."

Not less cogent were his arguments regarding the immense value of the old text of Scripture as compared with the new.

For the revolt against Nikon and his reformers, see Rambaud, History of Russia, vol. i, pp. 414–416; also Wallace, Russia, vol. ii, pp. 307–309; also Leroy Beaulieu, L'Empire des Tsars, vol. iii, livre iii.

Strange to say, on the development of Scripture interpretation, largely in accordance with the old methods, wrought, about the beginning of the eighteenth century, Sir Isaac Newton.

It is hard to believe that from the mind which produced the Principia, and which broke through the many time-honored beliefs regarding the dates and formation of scriptural books, could have come his discussions regarding the prophecies; still, at various points even in this work, his power appears. From internal evidence he not only discarded the text of the Three Witnesses, but he decided that the Pentateuch must have been made up from several books; that Genesis was not written until the reign of Saul; that the books of Kings and Chronicles were probably collected by Ezra; and, in a curious anticipation of modern criticism, that the book of Psalms and the prophecies of Isaiah and Daniel were each written by various authors at various dates. But the old belief in prophecy as prediction was too strong for him, and we find him applying his great powers to the elucidation of the details given by the prophets and in the Apocalypse to the history of mankind since unrolled, and tracing from every statement in prophetic literature its exact fulfillment even in the most minute particulars.

By the beginning of the eighteenth century the structure of scriptural interpretation had become enormous. It seemed destined to hide forever the real character of our sacred literature and to obscure the great light which Christianity had brought into the world. The Church, Eastern and Western, Catholic and Protestant, was content to sit in its shadow, and the great divines of all branches of the Church reared every sort of fantastic buttress to strengthen or adorn it. It seemed to be founded for eternity; and yet, at this very time when it appeared the strongest, a current of thought was rapidly dissolving away its foundations, and preparing that wreck and ruin of the whole fabric which is now, at the close of the nineteenth century, going on so rapidly.

The account of the movement thus begun is next to be given.*

HYDROGEN has at last been liquefied in quantities susceptible of examination, by Prof. Olzewski, of Cracow, who finds that its critical point—the temperature at which it passes from a liquid to a vapor—is −233° C., and its boiling point at normal pressure −343° C. Thus the last gas that has resisted liquefaction has yielded.

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* For Newton's boldness in textual criticism, compared with his credulity as to the literal fulfillment of prophecy, see his Observations upon the Prophecies of Daniel and the Apocalypse of St. John, in his works, edited by Horsley, London, 1785, vol. v, pp. 297–491.

PROFESSIONAL INSTITUTIONS.

II.—PHYSICIAN AND SURGEON.

By HERBERT SPENCER.

ALREADY, in Chapter II of the preceding part, have been given illustrations of the general truth that in rude tribes it is difficult to distinguish between the priest and the medicine-man. Their respective functions are commonly fulfilled by the same person. In addition to the instances there given, here are some others. According to Humboldt, "the Caribbee *marirris* are at once priests, jugglers, and physicians." Among the Tupis "the Payes, as they were called, were at once quacks, jugglers, and priests." Passing from South America to North, we read that the "Carriers know little of medicinal herbs. Their priest or magician is also the doctor;" and, of the Dakotahs, Schoolcraft says—"The Priest is both prophet and doctor." In Asia we meet with a kindred connection. In Southern India, the Kurumbas act as doctors to the Badagas, and it is said of them—"The Kurumbas also officiate as priests at their marriages and deaths." So is it among peoples further north. "Native doctors swarm in Mongolia. . . . They are mostly lamas. There are a few laymen who add medical practice to their other occupations, but the great majority of doctors are priests." It is the same on the other great continent. Reade tells us that in Equatorial Africa the fetish-man is doctor, priest, and witch-finder; and concerning the Joloffs and Eggarahs, verifying statements are made by Mollien and by Allen and Thomson.

This evidence, re-enforcing evidence given in the preceding part, and re-enforced by much more evidence given in the first volume of this work, shows that union of the two functions is a normal trait in early societies.

The origin of this union lies in the fact before named that the primitive priest and the primitive medicine-man both deal with supposed supernatural beings; and the confusion arises in part from the conceived characters of these ghosts and gods, some of which are regarded as always malicious, and others of which, though usually friendly, are regarded as liable to be made angry and then to inflict evils.

The medicine-man, dealing with malicious spirits, to which diseases among other evils are ascribed by savages, subjects his patients partly to natural agencies, but chiefly to one or other method of exorcism. Says Keating of the Chippewas, "their mode of treatment depends more upon the adoption of proper

spells than the prescription of suitable remedies." Among the Nootka Sound people,—

"Natural pains and maladies are invariably ascribed to the absence or other irregular conduct of the soul, or to the influence of evil spirits, and all treatment is directed to the recall of the former and to the appeasing of the latter."

So, too, of the Okanagans we read :—

"But here, as elsewhere, the sickness becoming at all serious or mysterious, medical treatment proper is altogether abandoned, and the patient committed to the magic powers of the medicine-man."

Sequent upon such beliefs in the supernatural origin of diseases are various usages elsewhere. It is said of the Karens that "when a person is sick, these people [medicine-men], for a fee, will tell what spirit has produced the sickness, and the necessary offering to conciliate it." Among the Araucanians, the medicine-man having brought on a state of trance, real or pretended, during which he is supposed to have been in communication with spirits, declares on his recovery—

"the nature and seat of the malady, and proceeds to dose the patient, whom he also manipulates about the part afflicted until he succeeds in extracting the cause of the sickness, which he exhibits in triumph. This is generally a spider, a toad, or some other reptile which he has had carefully concealed about his person."

Speaking of the Tahitian doctors, who are almost invariably priests or sorcerers, Ellis says that in cases of sickness they received fees, parts of which were supposed to belong to the gods: the supposition being that the gods who had caused the diseases must be propitiated by presents. A more advanced people exhibit a kindred union of ideas. Says Gilmour—

"Mongols seldom separate medicine and prayers, and a clerical doctor has the advantage over a layman in that he can attend personally to both departments, administering drugs on the one hand, and performing religious ceremonies on the other."

Hence the medical function of the priest. When not caused by angry gods diseases are believed to be caused by indwelling demons, who have either to be driven out by making the body an intolerable residence, or have to be expelled by superior spirits who are invoked.

But there is often a simultaneous use of natural and supernatural means, apparently implying that the primitive medicine-man, in so far as he uses remedies acting physically or chemically, foreshadows the physician; yet the apparent relationship is illusive, for those which we distinguish as natural remedies are not so distinguished by him. In the first volume, in the chapter on

Plant-Worship, it was shown that powerful effects wrought on the body by plants, and the product of plants, are supposed to be due to spirits dwelling in the plants. Hence the medicine-man, or "mystery-man," being concerned solely with supernatural causation of one or other kind, foreshadows the physician only to the extent of using some of the same means, and not as having the same ideas.

As we shall presently see, it is rather from the priest properly so called, who deals with ghosts not antagonistically but sympathetically, that the physician originates.

While the medicine-man is distinctive of small and undeveloped societies, the priest proper arises along with social aggregation and the formation of established government. In the preceding division of this work, Chapters III, IV, and V, we saw that since originally propitiation of the ghosts of parents and other members of each family is at first carried on by relatives, implying that the priestly function is generally diffused; and since this priestly function presently devolves on the eldest male of the family; and since, when chieftainship becomes settled and inheritable, the living chief makes sacrifices to the ghost of the dead chief, and sometimes does this on behalf of the people; there so arises an official priest, and it results that with enlargement of societies by union with subjugated tribes and the spread of the chieftain's power, now grown into royal power, over various subordinated groups, and the accompanying establishment of deputy rulers in these groups, who take with them the worship that arose in the conquering tribe, there is initiated a priesthood which, growing into a caste, becomes an agency for the dominant cult; and, from causes already pointed out, becomes the seat of culture in general.

From part of this culture, having its origin in preceding stages, comes greater knowledge of medicinal agents, which gradually cease to be conceived as acting supernaturally. Early civilizations show us the transition. Says Maspéro of the ancient Egyptians:—

> "The cure-workers are . . . divided into several categories. Some incline toward sorcery, and have faith in formulas and talismans only. . . . Others extol the use of drugs; they study the qualities of plants and minerals . . . and settle the exact time when they must be procured and applied. . . . The best doctors carefully avoid binding themselves exclusively to either method . . . their treatment is a mixture of remedies and exorcisms which vary from patient to patient. They are usually priests."

Along with this progress, there had gone on a differentiation of functions. Among the lower classes of the priesthood were the "pastophors, who . . . practiced medicine."

Respecting the state of things in Babylonia and Assyria, the evidence is not so clear. Says Lenormant of the Chaldæans:

"Il est curieux de noter que les trois parties qui composaient ainsi le grand ouvrage magique dont Sir Henry Rawlinson a retrouvé les débris, correspondent exactement aux trois classes de docteurs chaldéens que le livre de Daniel (i, 20 ; ii, 2 et 27 ; v, 11) énumère à côté des astrologues et des divins (*kasdim* et *gazrim*), c'est-à-dire les *khartumin* ou conjurateurs, les *hakamin* ou médecins, et les *asaphin* ou théosophes."

With like implications Prof. Sayce tells us that—

"The doctor had long been an institution in Assyria and Babyonia. It is true that the great bulk of the people had recourse to religious charms and ceremonies when they were ill, and ascribed their sickness to possession by demons instead of to natural causes. But there was a continually increasing number of the educated who looked for aid in their maladies rather to the physician with his medicine than to the sorcerer or priest with his charms."

But from these two statements taken together it may fairly be inferred that the doctors had arisen as one division of the priestly class.

Naturally it was with the Hebrews as with their more civilized neighbors. Says Gauthier—

"Chez les Juifs la médecine a été longtemps sacerdotale comme chez presque tous les anciens peuples ; les Lévites étaient les seuls médecins. . . . Chez les plus anciens peuples de l'Asie, tels que les Indiens et les Perses, l'art de guérir était également exercé par lès prêtres."

In later days this connection became less close, and there was a separation of the physician from the priest. Thus in Ecclesiasticus we read:—

"My son, in thy sickness be not negligent: but pray unto the Lord, and he will make thee whole. Leave off from sin, and order thine hands aright, and cleanse thy heart from all wickedness. Give a sweet savor, and a memorial of fine flour ; and make a fat offering. Then give place to the physician, for the Lord hath created him ; let him not go from thee, for thou hast need of him." (xxxviii, 15.)

Facts of congruous kinds are remarked on by Draper:—

"In the Talmudic literature there are all the indications of a transitional state, so far as medicine is concerned ; supernatural seems to be passing into the physical, the ecclesiastical is mixed up with the exact: thus a rabbi may cure disease by the ecclesiastical operation of laying on of hands ; but of febrile disturbances, an exact, though erroneous explanation is given, and paralysis of the hind legs of an animal is correctly referred to the pressure of a tumor on the spinal cord."

Concerning the origin of the medical man among the Hindus, whose history is so much complicated by successively superposed governments and religions, the evidence is confused. Accounts

agree, however, in the assertion that medicine was of divine origin: evidently implying its descent through the priesthood. In the introduction to Charaka's work, medical knowledge is said to have indirectly descended from Brahma to Indra, while "Bhâradvâja learned it from Indra, and imparted it to six Rishis, of whom Agnivâsa was one." The association of medical practice with priestly functions is also implied in the statement of Hunter that "the national astronomy and the national medicine of India alike derived their first impulses from the exigencies of the national worship." The same connection was shown during the ascendancy of Buddhism. "The science was studied in the chief centers of Buddhist civilization, such as the great monastic university of Nalanda, near Gayá."

Similar was the genesis of the medical profession among the Greeks. "The science [of medicine] was of divine origin, and the doctors continued, in a certain sense, to be accounted the descendants of Asklepios." As we read in Grote—

> "The many families or gentes called Asklêpiads, who devoted themselves to the study and practice of medicine, and who principally dwelt near the temples of Asklêpius, whither sick and suffering men came to obtain relief—all recognized the god [Asklêpius] not merely as the object of their common worship, but also as their actual progenitor."

In later times we see the profession becoming secularized.

> "The union between the priesthood and the profession was gradually becoming less and less close; and, as the latter thus separated itself, divisions or departments arose in it, both as regards subjects, such as pharmacy, surgery, etc., and also as respects the position of its cultivators."

Miscellaneous evidence shows that during early Roman times, when there existed no medical class, diseases were held to be supernaturally inflicted, and the methods of treating them were methods of propitiation. Certain maladies ascribed to certain deities prompted endeavor to pacify those deities; and hence there were sacrifices to Febris, Mephitis, Ossipaga, and Carna. An island in the Tiber, which already had a local healing god, became also the seat of the Æsculapius cult: that god having been appealed to on the occasion of an epidemic. Evidently, therefore, medical treatment at Rome, as elsewhere, was at first associated with priestly functions. Throughout subsequent stages the normal course of evolution is deranged by influences from other societies. Conquered peoples, characterized by actual or supposed medical skill, furnished the medical practitioners. For a long time these were dependents of patrician houses. Say Guhl and Koner—"Physicians and surgeons were mostly slaves or freedmen." And the medical profession, when it began to develop, was of foreign origin. Mommsen writes:—

"In 535 the first Greek physician, the Peloponnesian Archagathus, settled in Rome and there acquired such repute by his surgical operations, that a residence was assigned to him on the part of the state and he received the freedom of the city; and thereafter his colleagues flocked in crowds to Rome . . . the profession, one of the most lucrative which existed in Rome, continued a monopoly in the hands of the foreigners."

Opposed to paganism as Christianity was from the beginning, we might naturally suppose that the primitive association between the priestly and medical functions would cease when Christianity became dominant. But the roots of human sentiments and beliefs lie deeper than the roots of particular creeds, and are certain to survive and bud out afresh when an old creed has been superficially replaced by a new one. Everywhere pagan usages and ideas are found to modify Christian forms and doctrines, and it is so here. The primitive theory that diseases are of supernatural origin still held its ground, and the agency of the priest consequently remained needful. Of various hospitals built by the early Christians we read:—

"It was commonly a priest who had charge of them, as, at Alexandria, S. Isidore, under the Patriarch Theophilus; at Constantinople, St. Zoticus, and after him St. Samson."

Concerning the substitution of Christian medical institutions for pagan ones, it is remarked:—

"The destruction of the Asclepions was not attended by any suitably extensive measures for insuring professional education. . . . The consequences are seen in the gradually increasing credulity and imposture of succeeding ages, until, at length, there was an almost universal reliance on miraculous interventions."

But a more correct statement would be that the pagan conceptions of disease and its treatment re-asserted themselves. Thus, according to Sprengel, after the sixth century the monks practiced medicine almost exclusively. Their cures were performed by prayers, relics of martyrs, holy water, etc., often at the tombs of martyrs. The state of things during early mediæval times, of which we know so little, may be inferred from the fact that in the twelfth century the practice of medicine by priests was found to interfere so much with their religious functions that orders were issued to prevent it; as by the Lateran Council in 1123, the Council of Reims in 1131, and again by the Lateran Council in 1139. But the usage survived for centuries later in France and probably elsewhere; and it seems that only when a papal bull permitted physicians to marry, did the clerical practice of medicine begin to decline. Says Warton, "The physicians of the University of Paris were not allowed to marry till the year 1452."

In our own country a parallel relationship similarly survived.

In 1456 "the practice of medicine was still, to some extent, in the hands of the clergy." That ecclesiastics exercised authority over medical practice in the time of Henry VIII, is shown by a statute of his third year, which reads:—

"It is enacted that no person in London, or seven miles thereof, shall practice as a physician or surgeon without examination and license of the Bishop of London, or of the Dean of Paul's, duly assisted by the faculty; or beyond these limits, without license from the bishop of the diocese, or his vicar-general, similarly assisted."

And it is alleged that down to the early part of our own century there remained with the Archbishop of Canterbury a latent power of granting medical diplomas. So that the separation between "soul-curer and body-curer," which goes on as savage peoples develop into civilized nations, has but very gradually completed itself even throughout Christian Europe.

This continuity of belief and of usage is even still shown in the surviving interpretations of certain diseases by the Church and its adherents; and it is even still traceable in certain modes of medical treatment and certain popular convictions connected with them.

In the minds of multitudinous living people there exists the notion that epidemics are results of divine displeasure; and no less in the verdict "Died by the visitation of God," than in the vague idea that recovery from, or fatal issue of, a disease, is in part supernaturally determined, do we see that the ancient theory lingers. Moreover, there is a predetermination to preserve it. When, some years ago, it was proposed to divide hospital patients into two groups, for one of which prayers were to be offered and for the other not, the proposal was resented with indignation. There was a resolution to maintain the faith in the curative effect of prayer, whether it was or was not justified by the facts; to which end it was felt desirable not to bring it face to face with the facts.

Again, down to the present day epilepsy is regarded by many as due to the possession by a devil; and the prayer-book contains a form of exorcism to be gone through by a priest to cure maladies supernaturally caused. Belief in the demoniacal origin of some diseases is indeed a belief necessarily accepted by consistent members of the Christian Church; since it is the belief taught to them in the New Testament—a belief, moreover, which survives the so-called highest culture. When, for example, we see a late Prime Minister, deeply imbued with the university spirit, publicly defending the story that certain expelled devils entered into swine, we are clearly shown that the theory of the demoniacal origin of some disorders is quite consistent with the current

creed. And we are shown how, consequently, there yet remains a place for priestly action in medical treatment.

Let me add a more remarkable mode in which the primitive theory has persisted. The notion that the demon who was causing a disease must be driven out, continued, until recent times, to give a character to medical practice, and even now influences the conceptions which many people form of medicines. The primitive medicine-man, thinking to make the body an intolerable habitat for the demon, exposed his patient to this or that kind of alarming, painful, or disgusting treatment. He made before him dreadful noises and fearful grimaces, or subjected him to an almost unbearable heat, or produced under his nose atrocious stenches, or made him swallow the most abominable substances he could think of. As we saw in the case cited from Ecclesiasticus, the idea, even among the semi-civilized Hebrews, long remained of this nature. Now there is abundant proof that, not only during mediæval days but in far more recent days, the efficiency of medicines was associated in thought with their disgustingness: the more repulsive they were the more effectual. Hence Montaigne's ridicule of the monstrous compounds used by doctors in his day—"dung of elephant, the left foot of a tortoise, liver of a mole, powdered excrement of rats, etc." Hence a receipt given in Vicarie's Treasure of Anatomy (1641)—"Five spoonfuls of knave child urine of an innocent." Hence "the beliefs that epilepsy may be cured by drinking water out of the skull of a suicide or by tasting the blood of a murderer;" that "moss growing on a human skull, if dried, powdered, and taken as snuff, will cure the headache;" and that the halter and chips from the gibbet on which malefactors have been executed or exposed have medicinal properties. And there prevails in our own days among the uncultured and the young a similarly-derived notion. They betray an ingrained mental association between the nastiness of a medicine and its efficiency: so much so, indeed, that a medicine which is pleasant is with difficulty believed to be a medicine.

As with evolution at large, as with organic evolution, and as with social evolution throughout its other divisions, secondary differentiations accompany the primary differentiation. While the medical agency separates from the ecclesiastical agency, there go on separations within the medical agency itself.

The most pronounced division is that between physicians and surgeons. The origin of this has been confused in various ways, and seems now the more obscure because there has been of late arising not a further distinction between the two but a fusion of them. All along they have had a common function in the treatment of ordinary disorders and in the uses of drugs; and the

"general practitioner" has come to be one who avowedly fulfills the functions of both. Indeed in our day it is common to take degrees in both medicine and surgery, and thus practically to unite these sub-professions. Meanwhile the two jointly have become more clearly marked off from those who carry out their orders. Down to recent times it was usual not only for a surgeon to compound his own medicines, but a physician also had a dispensary and sometimes a compounder: an arrangement which still survives in country districts. Nowadays, however, both medical and surgical practitioners in large places depute this part of their business to chemists and druggists.

But the apparent nonconformity to the evolutionary process disappears if we go back to the earliest stages. The distinction between doctor and surgeon is not one which has arisen by differentiation, but is one which asserted itself at the outset. For while both had to cure bodily evils, the one was concerned with evils supposed to be supernaturally inflicted, and the other with evils that were naturally inflicted—the one with diseases ascribed to possessing demons, the other with injuries inflicted by human beings, by beasts, and by inanimate bodies. Hence we naturally find in the records of early civilizations more or less decided distinctions between the two.

"The Brahmin was the physician; but the important manual department of the profession could not be properly exercised by the pure Brahmin; and to meet this difficulty, at an early period, another caste was formed, from the offspring of a Brahmin with a daughter of a Vaishya."

There is evidence implying that the division existed in Egypt before the Christian era; and it is alleged that the Arabians systematically divided physics, surgery, and pharmacy into three distinct professions. Among the Greeks, however, the separation of functions did not exist: "the Greek physician was likewise a surgeon"—was likewise a compounder of his own medicines. Bearing in mind these scattered indications yielded by early societies, we must accept in a qualified way the statements respecting the distinctions between the two in mediæval times throughout Europe. When we remember that during the dark ages the religious houses and priestly orders were the centers of such culture and skill as existed, we may infer that priests and monks acted in both capacities; and that hence, at the beginning of the fifth century, surgery "was not yet a distinct branch of the practice of medicine." Still, it is concluded that clerics generally abstained from practicing surgery, and simply superintended the serious operations performed by their assistants: the reason being perhaps, as alleged, that the shedding of blood by clerics being interdicted, they could not themselves use the operating

knife. And this may have been a part cause for the rise of those secular medical practitioners who, having been educated in the monastic schools, were, as barber-surgeons, engaged by the larger towns in the public service. Probably this differentiation was furthered by the papal edicts forbidding ecclesiastics from practicing medicine in general; for, as is argued, there may hence have arisen that compromise which allowed the clergy to prescribe medicines while they abandoned surgical practice into the hands of laymen.

Along with this leading differentiation, confused in the ways described, there have gone on, within each division, minor differentiations. Some of these arose and became marked in early stages. In ancient India—

"A special branch of surgery was devoted to rhinoplasty, or operations for improving deformed ears and noses, and forming new ones."

That the specialization thus illustrated was otherwise marked, is implied by the statement that "no less than a hundred and twenty-seven surgical instruments were described in the works of the ancient surgeons;" and by the statement that in the Sanskrit period—

"The number of medical works and authors is extraordinarily large. The former are either systems embracing the whole domain of the science, or highly special investigations of single topics."

So was it, too, in ancient Egypt. Describing the results, Herodotus writes:—

"Medicine is practiced among them [the Egyptians] on a plan of separation; each physician treats a single disorder, and no more: thus the country swarms with medical practitioners, some undertaking to cure diseases of the eye, others of the head, others again of the teeth, others of the intestines, and some those which are not local."

Though among the Greeks there was for a long period no division even between physician and surgeon, yet in later days "the science of healing became divided into separate branches, such as the arts of oculists, dentists, etc."

Broken evidence only is furnished by intermediate times; but our own times furnish clear proofs of progress in the division of labor among medical men. We have physicians who devote themselves, if not exclusively, still mainly, to diseases of the lungs, others to heart diseases, others to disorders of the nervous system, others to derangements of digestion, others to affections of the skin; and we have hospitals devoted some to this and some to that kind of malady. So, too, with surgeons. Besides such specialists as oculists and aurists, there exist men noted for skillful operations on the bladder, the rectum, the ovaria, as well as men whose particular aptitudes are in the treatment of breakages

and dislocations, to say nothing of the quacks known as "bone-setters," whose success, as has been confessed to me by a surgeon, is often greater than that of men belonging to his own authorized class.

In conformity with the normal order of evolution, integration has accompanied this differentiation. From the beginning have been shown tendencies toward unions of those who practiced the healing art. There have arisen institutions giving a certain common education to them; associations of those whose kinds of practice were similar; and, in later times, certain general, though less close, associations of all medical men. In Alexandria—

"The temple of Serapis was used for a hospital, the sick being received into it, and persons studying medicine admitted for the purpose of familiarizing themselves with the appearance of disease, precisely as in such institutions at the present time."

In Rome, along with the imported worship of Æsculapius, there went the communication of knowledge in the places devoted to him. During early mediæval times the monasteries, serving as centers of instruction, gave some embodiment to the medical profession, like that which our colleges give. In Italy there later arose institutions for educating physicians, as the medical school of Salerno in 1140. In France before the end of the thirteenth century the surgeons had become incorporated into a distinct college, following, in this way, the incorporated medical faculty; and while thus integrating themselves they excluded from their class the barbers who, forbidden to perform operations, were allowed only to dress wounds, etc. In our own country there have been successive consolidations. The barber-surgeons of London were incorporated by Edward IV, and in the fifteenth century the College of Physicians was founded, and "received power to grant licenses to practice medicine—a power which had previously been confined to the bishops." Progress in definiteness of integration was shown when, in Charles I's time, persons were forbidden to exercise surgery in London and within seven miles, until they had been examined by the company of barbers and surgeons; and also when, by the 18th of George II, excluding the barbers, the Royal College of Surgeons was formed. At the same time there have grown up medical schools in various places which prepare students for examination by these incorporated medical bodies: further integrations being implied. Hospitals, too, scattered throughout the kingdom, have become places of clinical instruction, some united to colleges and some not. Another species of integration has been achieved by medical journals, weekly and quarterly, which serve to bring into communication educational institutions, incorporated bodies, and the whole profession.

Two additional facts should be noted before closing the chapter. One is the recent differentiation by which certain professors of anatomy and physiology have been made into professors of biology. In them the study of human life has developed into the study of life at large. And it is interesting to see how this specialization, seemingly irrelevant to medical practice, eventually becomes relevant; since the knowledge of animal life obtained presently extends the knowledge of human life and so increases medical skill. The other fact is that along with incorporation of authorized medical men there has arisen jealousy of the unincorporated. Like the religious priesthood, the priesthood of medicine persecutes heretics and those who are without diplomas. There has long been, and still continues, denunciation of unlicensed practitioners, as also of the "counter-practice" carried on by chemists and druggists. That is to say, there is a constant tendency to a more definite marking off of the integrated professional body.

TWO-OCEAN PASS.

By BARTON WARREN EVERMANN, Ph. D.,
ICHTHYOLOGIST OF THE UNITED STATES FISH COMMISSION.

IT was while the Great Ice King still ruled over all America from the pole to the middle United States that Lake Lahontan and Lake Bonneville spread their waters over hundreds of square miles of our western territory; Lahontan where we now have the sage plains and alkali sinks of Nevada, and Bonneville covering the greater part of Utah west of the Wasatch Mountains, but now reduced to Sevier, Utah, and Great Salt Lakes, the last shallow remnants of a once mighty inland sea. It was probably long before these great lakes had dried up, while their waters were yet fresh and sweet, that occurred an event which wrought a vast change in the physical geography of that region. Somewhere, but no one is yet certain *exactly where*, one or more great fissures opened in the earth, and there poured out an incredible amount of lava which covered not less than one hundred and fifty thousand square miles with one vast sheet of rhyolite hundreds, in some places thousands, of feet in thickness. Northern California, northwestern Nevada, nearly all of Oregon, Washington, and Idaho, and parts of Wyoming, the Yellowstone Park, Montana, and British Columbia were all covered by this stupendous flow.

The effect of this lava flow upon the present distribution of the fishes of that region is known to have been very great, and we are now beginning to understand some of the most important factors of that distribution—a distribution which, until recently, presented many anomalies.

It has been my good fortune to make explorations in Montana, Wyoming, Idaho, and the Yellowstone Park which have cleared up some of these difficulties. The presence of trout in Yellowstone Lake and the total absence of all fish from the other large lakes of the park was one of the most interesting of these anomalies, and it is to its explanation that this article is devoted.

It is certain that all the streams and lakes of the territory covered by the lava flow were wiped out of existence by the fiery flood, and all terrestrial and aquatic life destroyed. Many long years must have passed before this lava sheet became sufficiently cooled to permit the formation of new streams; but a time finally came when the rains, falling upon the gradually cooling rock, were no longer converted into steam and thrown back into the air, only to condense and fall again, but, being able to remain in liquid form upon the rock, sought lower levels, and thus new streams began to flow. And then the fishes in the connecting streams below, which had not been destroyed by the lava flow, began to invade the desolated region and repeople its waters.

The rhyolite, obsidian, and trachyte were very hard and eroded slowly, but when the streams reached the edge of the lava field they encountered rock which was comparatively soft and which wore away rapidly. The result is that every stream leaving the Yellowstone Park has one or more great waterfalls in its course where it leaves the lava sheet. Notable among these streams are Lewis River, the outlet of Lewis and Shoshone Lakes; Yellowstone River, the outlet of Yellowstone Lake; Gardiner, Gibbon, and Firehole Rivers, and Lava, Lupine, Glen, Crawfish, Tower, and Cascade Creeks, all leaving the lava sheet in beautiful falls, varying from thirty feet to over three hundred feet in vertical descent. The following is a list of the principal waterfalls in the streams in and about the park, each one of which is supposed to form an insurmountable barrier to the ascent of fish:

Great Falls of the Yellowstone	308	feet.
Upper Falls of the Yellowstone	109	"
Crystal Falls in Cascade Creek	129	"
Tower Falls in Tower Creek	132	"
Undine Falls in Lava Creek	60	"
Lower Falls in Lava Creek	50	"
Wraith Falls in Lupine Creek	100	"
Osprey Falls in Gardiner River	150	"
Rustic Falls in Glen Creek	70	"
Virginia Cascades in Gibbon River	60	"
Gibbon Falls in Gibbon River	80	"
Keppler Cascade in Firehole River	80	"
Upper Falls in Lewis River	50	"
Lower Falls in Lewis River	30	"
Moose Falls in Crawfish Creek	30	"

TWO-OCEAN PASS, LOOKING EAST.

Besides these, there are almost innumerable falls in the smaller streams and brooks, but of them we take no account. When it is remembered that nearly all these falls are within the limits of an area fifty-five by sixty-five miles, one can get some idea of the grandeur and beauty of the Yellowstone National Park. It is doubtful if any other similar area in the world affords so many magnificent waterfalls, beautiful cascades, seething torrents, and abysmal gorges as are found here. But these are among the least of the strange and wonderful things in this wonderland, where geysers great and small, mud springs and boiling paint-pots, and petrified forests so abound. With scarcely an exception all these streams and lakes are of the best of pure, clear, cold water, well supplied with insect larvæ, the smaller crustacea, and various other kinds of the smaller animal and plant forms sufficient in amount to support an immense fish life. But it is a strange and interesting fact that, with the exception of Yellowstone Lake and River, these waters were wholly barren of fish life until recently stocked by the United States Fish Commission. The river and lake just named are well filled with the Red-throated trout (*Salmo mykiss lewisi*), and this fact is the more remarkable when it is remembered that the falls in the lower Yellowstone River are one hundred and nine and three hundred and eight feet, respectively—by far the greatest found in the park.

The total absence of fish from Lewis and Shoshone Lakes and the numerous other small lakes and streams of the park is certainly due to the various falls in their lower courses, which have proved impassable barriers to the ascent of fishes from below; for in every one of these streams, just below the falls, trout and in some cases other species of fishes are found in abundance. But to account for the presence of trout in Yellowstone Lake was a matter of no little difficulty. If a fall of thirty to fifty feet in Lewis River has prevented trout from ascending to Lewis and Shoshone Lakes, why have not the much greater falls in the Yellowstone proved a barrier to the ascent of trout to Yellowstone Lake? Certainly no fish can ascend these falls, and we must look elsewhere for the explanation.

Many years ago the famous old guide, Jim Bridger, told his incredulous friends that he had found, on the divide west of the upper Yellowstone, a creek which flowed in both directions—one end flowing east into the Yellowstone, the other west into Snake River. But, as he also told about many other strange and to them impossible things which he had seen—among which were a glass mountain, and a river which ran down hill so fast that the water was made boiling hot—they were not disposed to acknowledge the existence of his "Two-Ocean Creek." Subsequent events

UPPER FALLS OF THE YELLOWSTONE RIVER. One hundred and nine feet.

however, showed that the strange stories of Jim Bridger were not without some elements of truth.

Two-Ocean Pass was visited by Captain Jones in 1873, by Dr. F. V. Hayden in 1878, and by Mr. Arnold Hague in 1884. The observations made by these various explorers seemed to indicate that Two-Ocean Pass is a nearly level meadow, near the center of which is a marsh, which, in times of wet weather, becomes a small lake, and that "a portion of the waters from the surrounding mountains accumulates in the marshy meadows and gradually gravitates from either side into two small streams, one of which flows to the northeast, the other to the southwest" (Hayden).

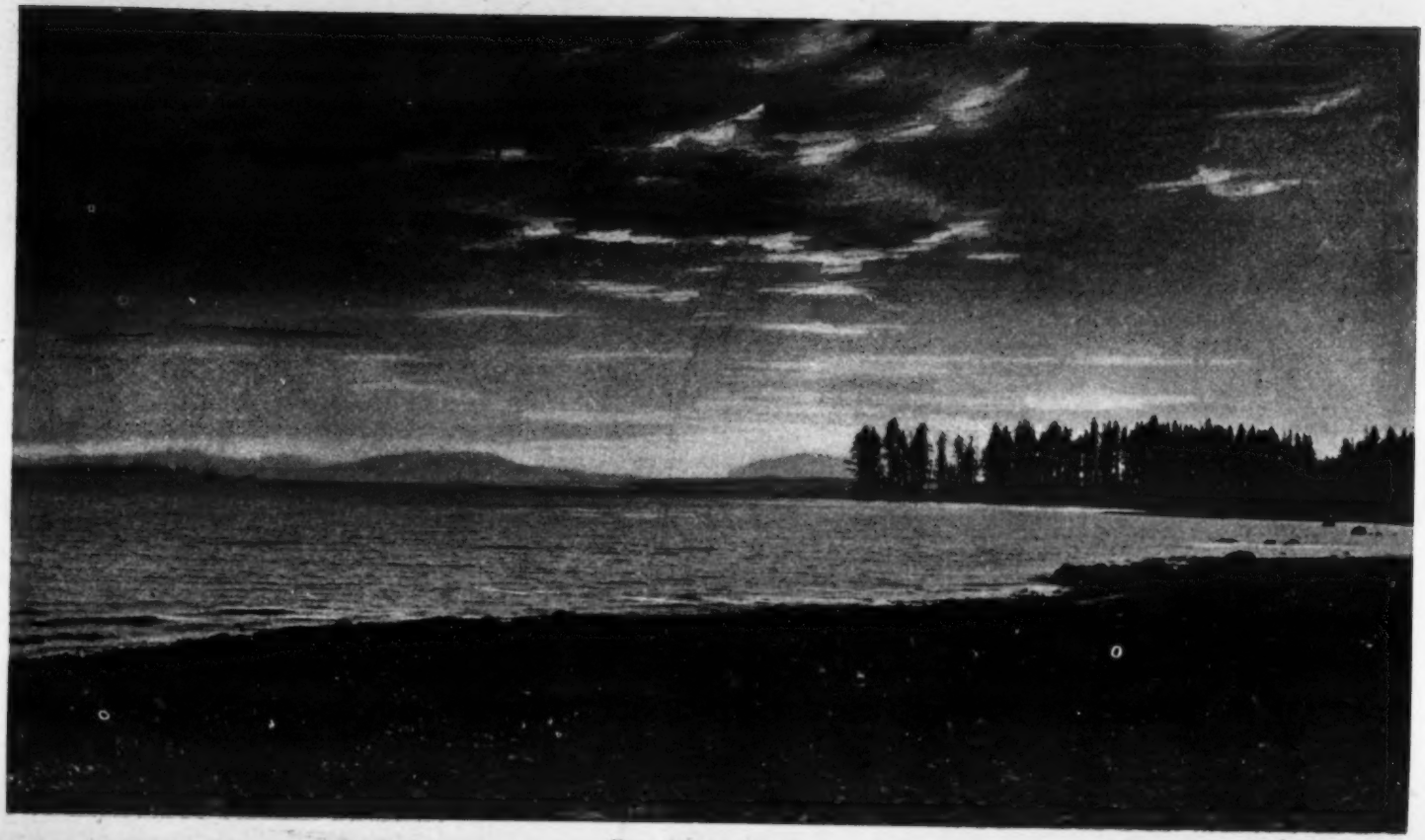
From these reports it began to be suspected that trout, ascending Pacific Creek from Snake River, might, in time of high water, pass through the lake in Two-Ocean Pass and descend Atlantic Creek and the upper Yellowstone to Yellowstone Lake, and thus would the origin of the trout of that lake be explained. Dr. Jordan, who spent some time in the park in 1889, was impressed with the probable correctness of this explanation, but did not visit Two-Ocean Pass.

In 1891, while carrying on certain investigations in Montana and the Yellowstone Park, under the direction of the United States Commissioner of Fish and Fisheries, Colonel Marshall McDonald, I was instructed to visit Two-Ocean Pass and determine definitely the conditions which obtain there.

On August 7th, with Billy Hofer, that prince of mountaineers, as our guide, we started out from the Mammoth Hot Springs with a pack train of ten pack horses and eight saddle horses. Our route led us through all the geyser basins of the park, and we reached Two-Ocean Pass August 17th, where we remained long enough to make a careful examination.

This pass is a high mountain meadow, about eight thousand two hundred feet above the sea, and situated just south of the park, in longitude 110° 10′, latitude 44° 3′. It is surrounded on all sides by rather high mountains, except where the narrow valleys of Atlantic and Pacific Creeks open out from it. Running back among the mountains to the northward are two small cañons, down which come two small streams. On the opposite side is another cañon, down which comes another small stream. The extreme length of the meadow from east to west is about a mile, while the width from north to south is not much less. The larger of the streams coming in from the north is Pacific Creek, which, after winding along the western side of the meadow, turns abruptly westward, leaving the pass through a narrow gorge. Receiving numerous small affluents, Pacific Creek soon becomes a good-sized stream, which finally unites with Buffalo Creek a few miles above where the latter stream flows into Snake River.

Shoshone Lake, North Shore.



YELLOWSTONE LAKE.

Atlantic Creek was found to have two forks entering the pass. At the north end of the meadow is a small wooded cañon, down which flows the North Fork. This stream hugs the border of the flat very closely. The South Fork comes down the cañon on the south side, skirting the brow of the hill a little less closely than does the North Fork. The two, coming together near the middle of the eastern border of the meadow, form Atlantic Creek, which, after a course of a few miles, flows into the Upper Yellowstone. But the remarkable phenomena exhibited here remain to be described.

Each fork of Atlantic Creek, just after entering the meadow, divides as if to flow around an island; but the stream toward the meadow, instead of returning to the portion from which it had parted, continues its westerly course across the meadow. Just before reaching the western border the two streams unite, and then pour their combined waters into Pacific Creek; thus are Atlantic and Pacific Creeks united, and a continuous water way from the mouth of the Columbia, *via* Two-Ocean Pass, to the Gulf of Mexico is established. Two-Ocean Creek is not a myth but a verity, and Jim Bridger is vindicated. We stood upon the bank of either fork of Atlantic Creek, just above the place of the "parting of the waters," and watched the stream pursue its rapid but dangerous and uncertain course along the *very crest* of the "*Great Continental Divide.*" A creek flowing along the ridge-pole of a continent is unusual and strange, and well worth watching and experimenting with. So we waded to the middle of the North Fork, and, lying down upon the rocks in its bed, we drank the pure icy water that was hurrying to the Pacific, and, without rising, but by simply bending a little to the left, we took a draught from that portion of the stream which was just deciding to go east, *via* the Missouri-Mississippi route, to the Gulf of Mexico. And then we tossed chips, two at a time, into the stream. Though they would strike the water within an inch or so of each other, not infrequently one would be carried by the current to the left, keeping in Atlantic Creek, while the other might be carried a little to the right and enter the branch running across the meadow to Pacific Creek; the one beginning a journey which will finally bring it to the great gulf, the other entering upon a long voyage in the opposite direction to Balboa's ocean.

Pacific Creek is a stream of good size long before it enters the pass, and its course through the meadow is in a definite channel; but not so with Atlantic Creek. The west bank of each fork is low, and the water is liable to break through anywhere, and thus send a part of its water across to Pacific Creek. It is probably true that one or two branches always connect the two creeks under ordinary conditions, and that, following heavy rains, or when

the snows are melting, a much greater portion of the water of Atlantic Creek finds its way across the meadow to the other.

Besides the channels already mentioned, there are several more or less distinct ones that were dry at the time of our visit. As

SALMO MYKISS Walbaum. Red-throated trout; adult; one half natural size.

SALMO MYKISS. Red-throated trout; young; natural size.

already stated, the pass is a nearly level meadow, covered with a heavy growth of grass and many small willows one to three feet high. While it is somewhat marshy in places, it has nothing of the nature of a lake about it. Of course, during wet weather the

small springs at the borders of the meadow would be stronger; but the important facts are that there is no lake or even marsh there, and that neither Atlantic nor Pacific Creek has its rise in the meadow. Atlantic Creek, in fact, comes into the pass as two good-sized streams from opposite directions, and leaves it by at least four channels, thus making an island of a considerable portion of the meadow. And it is certain that there is, under ordinary circumstances, a continuous waterway through Two-Ocean Pass of such a character as to permit fishes to pass easily and readily from Snake River over to the Yellowstone, or in the opposite direction. Indeed, it is possible, barring certain falls in

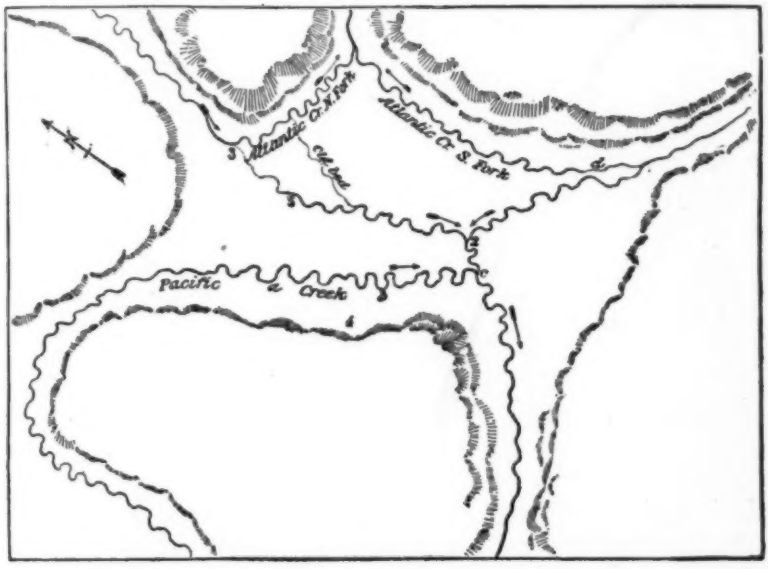


DIAGRAM SHOWING RELATION OF STREAMS IN TWO-OCEAN PASS.

Snake River, for a fish so inclined to start at the mouth of the Columbia, travel up that great river to its principal tributary, the Snake, thence on through the long, tortuous course of that stream, and, under the shadows of the Grand Tétons, enter the cold waters of Pacific Creek, by which it could journey on up to the very crest of the Great Continental Divide to Two-Ocean Pass; through this pass it may have a choice of two routes to Atlantic Creek, in which the down-stream journey is begun. Soon it reaches the Yellowstone, down which it continues to Yellowstone Lake, then through the lower Yellowstone out into the turbid waters of the Missouri. For many hundred miles it may continue down this mighty river before reaching the Father of Waters, which will finally carry it to the Gulf of Mexico—a wonderful journey of nearly six thousand miles, by far the longest possible fresh-water journey in the world.

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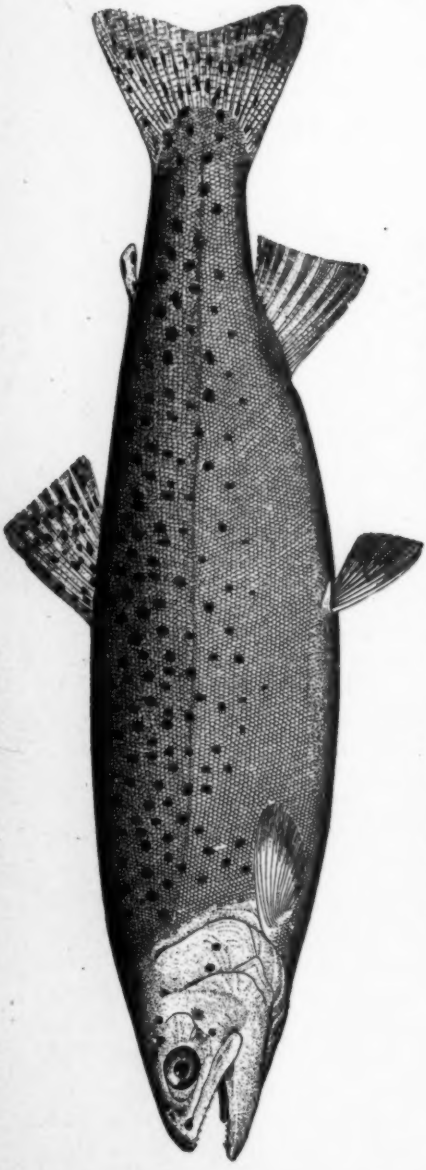

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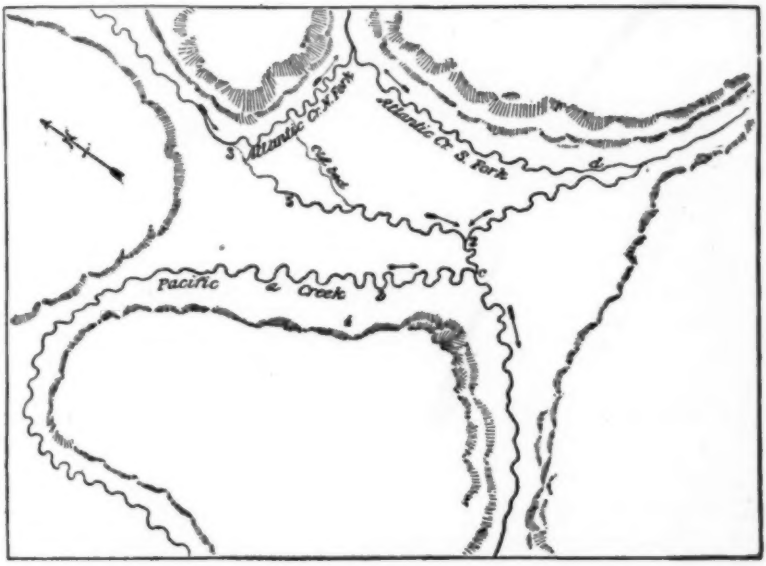

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We found trout in Pacific Creek at every point where we examined it. In Two-Ocean Pass we obtained specimens from each of the streams, and in such positions as would have permitted them to pass easily from one side of the divide to the other. We also caught trout in Atlantic Creek below the pass, and in the upper Yellowstone, where they were abundant.

Thus it is certain that there is no obstruction even in dry weather to prevent the passage of trout from the Snake River to Yellowstone Lake; it is quite evident that trout do pass over in this way; and it is almost absolutely certain that Yellowstone Lake was stocked with trout from the west, *via* Two-Ocean Pass.

From the basin of Snake River above Shoshone Falls we know at least twelve different species of fishes, but of all these the trout is the only one which has been able to pass over the Continental Divide and establish itself in Yellowstone Lake and its tributary streams, for no other species is known from those waters. But these twelve species are, as a rule, fishes of intermediate altitudes, rarely ascending into streams so cold as Pacific Creek. The only one which accompanies the trout into Pacific Creek is the blob (*Cottus bairdi punctulatus*), which we found even in Two-Ocean Pass, but it has never been seen on the Yellowstone side of the pass.

THE DECLINE IN RAILWAY CHARGES.

By H. T. NEWCOMB.

THE efficiency of any general system of transportation necessarily depends upon its safety, speed, and cost, and of these the last is clearly of paramount importance, for, unless charges can be made sufficiently moderate, no means of transportation can be generally available to the public, even though it possesses in the highest degree each of the other qualities. The superiority of railways as a means of moving passengers and freight between localities not connected by natural waterways lies primarily in the fact that they furnish transportation at a cost so low when compared with all other means of transportation that even the highest railway charges are relatively insignificant.

Competent authority has stated that, under the best methods of transportation over ordinary highways, wheat, the most valuable of cereal products, would bear transportation only two hundred and fifty miles to markets where it would sell for a dollar and a half per bushel, and that the market for corn at seventy-five cents per bushel must be within a radius of a hundred and fifty miles from the point of production. To-day, both of these products are carried from the great surplus-producing regions

west of the Mississippi River and sold at much lower prices than those named, in order to supply the denser populations located in the Eastern States and in Europe. Grain and flour are now carried from Chicago to New York over railway routes ranging from nine hundred and twelve to a thousand and forty-two miles in length, for twenty cents per hundred pounds, or only about four and a third mills per ton per mile for the shorter distance.

Dry goods, such as calicoes, Canton flannel, canvas, linen crash, ginghams, jeans, and sheetings, are taken from Boston to Vicksburg, Miss., about fifteen hundred and seventy miles, for fifty cents per hundred pounds, or a little more than six and a third mills per ton per mile. The rate on canned goods, including fish, fruits, meats, and vegetables, from San Francisco to St. Louis over rail lines from twenty-two hundred and eighty to twenty-nine hundred and fifty miles in length, is seventy-five cents per hundred pounds, or about one half of one cent per ton per mile.

These are merely examples of charges on important articles of commerce selected at random and without any intention of showing the lowest charges in existence, as will be clearly apparent when it is added that the average charge upon all freight traffic carried by rail in the United States during the year ending on June 30, 1894, was only 0·866 cent per ton per mile. The average for the States of Ohio, Indiana, Michigan, and the portions of New York and Pennsylvania situated west of Buffalo and Pittsburg was only 0·682 cent during the same year.

Although the immediate effect of the introduction of railway transportation must have been seen in rates very much lower than any previously available, and the consequent extension of the radii of the areas available for maketing surplus products, the present exceedingly low charges have been reached through a long and steady process during which the tendency toward lower rates has become one of the most generally recognized characteristics of railway development. While the existence of this tendency has been generally remarked, little attempt has been made to trace its extent, and even when the effort is made the investigation is found to be attended with numerous difficulties, owing to the absence of adequate records of the early period of railway development. This is especially to be regretted in view of the paramount importance of complete information regarding our railway system, at a time when its effective regulation by legislative authority is one of the problems of government attracting widest attention, and perhaps even more than others requiring in its solution the co-operation of enlightened public sentiment with ripe experience and skillful statecraft.

Fortunately, many railways have preserved data showing the

average charges per ton per mile during each year on all freight carried over their lines, and from these it is possible to present an interesting comparison of present with former charges. Such a comparison has the advantage that it gives the average of all charges, and therefore presents the actual net result of all changes, whether advances or reductions. It has the concurrent disadvantage that it fails to take account of the large increase in long-distance traffic, which is naturally carried at lower average rates per mile, and in consequence may show an apparent decline when charges for exactly similar service have remained stationary. The error from this cause is not, however, believed to be of such importance as to materially influence the result.

According to the last annual report made by the statistician of the Interstate Commerce Commission, the aggregate transportation of freight by the railways of the United States during the year ending on June 30, 1893, was equivalent to moving 93,588,111,833 tons one mile. Estimating the population at 66,551,571, which allows an annual increase of one and a quarter millions since 1890, this was equal to moving fourteen hundred and six tons one mile *per capita* of population.

Upon this basis the following table has been prepared, showing the average cost of moving fourteen hundred and six tons of freight one mile over important railways in each section of the country during every fifth year from 1852, for which the average rates per ton per mile could be obtained, and during 1893:

Year.	CHARGE FOR CARRYING 1,406 TONS OF FREIGHT ONE MILE AT AVERAGE RATE PER TON PER MILE DURING EACH YEAR.									
	Fitchburg R. R.	New York, Lake Erie and Western R. R.	Pennsylvania R. R.	Lake Shore and Michigan Southern Ry.	Illinois Central R. R.	Denver and Rio Grande R. R.	Louisville and Nashville R. R.	Chicago, Milwaukee and St. Paul Ry.	Union Pacific Ry.	United States.
1852.....	$43 87	$27 42	$76 21							
1857.....	55 26	34 59	33 88	$38 52						
1862.....	52 73	26 57	28 68	29 53	$27 56					
1867.....	59 19	28 68	29 24	34 17	40 77		$58 07	$55 40		
1872.....	55 12	21 51	20 53	19 26	30 37	$86 33	32 34	34 17	$32 90	
1877.....	29 24	13 50	14 20	12 09	25 59	43 45	24 75	29 24	27 00	
1882.....	16 45	10 55	12 23	8 86	19 97	51 32	18 98	20 81	31 07	$17 37
1887.....	15 89	9 70	10 26	9 42	15 33	33 60	14 34	15 33	19 97	14 54
1892.....	13 01	8 63	9 10	8 46	12 77	26 19	13 33	14 43	15 20	12 63
1893.....	12 98	8 87	8 72	8 42	11 88	24 76	12 89	14 43	14 52	12 34

The foregoing statement shows reductions startling in amount and distributed throughout all sections of the country. It is seen that the Fitchburg Railroad now receives only $13.10 for an amount of transportation for which as late as the year 1867 it would have charged $59.19, while other railways show even greater proportionate reductions. Similar data, including all railway

traffic, are not available for the years prior to 1882, but reductions since that time are shown to have been extensive.

It should not, however, be understood that the amount paid *per capita* for freight transportation by rail has decreased in the proportion shown by these figures. The most obvious result of declining rates is an extension of the utility of transportation facilities, as is amply shown by the statistics of freight movement. During 1882 the total railway freight service was equal to only 39,302,209,249 ton-miles, or about seven hundred and fifty-two tons carried one mile *per capita*, and the decline in the average charge per ton-mile from 1·236 cent in that year to 0·878 cent in 1893 was accompanied by an increase in the volume of traffic of nearly two hundred and fifty per cent, and in the amount of transportation *per capita* to almost twice that of 1882. The increase in tonnage movement in proportion to population was about eighty-seven per cent, and in the aggregate sum received therefor by the railways only thirty-seven per cent.

It will not be sufficent to abandon the investigation of changes in the charges for moving freight at this stage, nor to remain satisfied with mere general averages of those charges. The more minute inquiry which deals with actual rates upon specific commodities of commercial importance affords quite as interesting and it is confidently believed equally important and significant results. The rate from Chicago to New York on grain and flour,

	WHEAT.		
	Export price per bushel.	Average rate per bushel.	Number of bushels which could be carried from Chicago to New York for export price of one bushel.
1867	$1 27	44·75 cents.	2·84
1872	1 47	34·99 "	4·20
1877	1 17	20·50 "	5·71
1882	1 19	14·47 "	8·22
1887	89	15·75 "	5·65
1892	1 03	13·80 "	7·46
1893	80	14·63 "	5·47
1894	67	12·88 "	5·20

which are nearly always classed together for rate-making purposes, is indisputably the most important single rate that could be selected. It derives its prominence not alone from the fact that it applies to the most important agricultural and food products, when shipped from the greatest grain market in the world to its principal port of export, but also because it is the basis of all charges on grain and flour shipped from the western regions of surplus production to the Eastern States. Any modification of this rate, therefore, effects a corresponding change in the transportation charge on nearly every bushel of grain and

barrel of flour produced in the United States, and directly affects the price to producer and consumer of these important commodities.

The preceding table shows the average wheat rate from Chicago to New York, the average export price as compiled by the Bureau of Statistics, and the number of bushels which could be shipped between those points for a sum equal to the export price during each of the years named.

This table shows that the reduction in rates has been considerably in excess of that in the price of wheat, and the same is probably true of the other cereal products and of flour.

The rates charged on the artificial fertilizers so largely used on the cotton plantations of the south are of great importance to the producers of that section. Taking that from Charleston, S. C., to Albany, Ga., as an example, it is found to have been reduced from $4.30 per ton in 1884 to $2.59 in 1894. Equally important changes have taken place in the rates on the product itself, cotton being now shipped from Memphis to Boston *via* rail for fifty-five and a half cents per one hundred pounds, a reduction of about thirty per cent from the rate in force during 1880, which was seventy-nine cents.

Nearly every one is familiar with the importance of the live-stock movement from the southwest to Chicago. Shipments of live cattle are concentrated at the railway centers on the Missouri River and are carried forward to destination in train loads. The rate per car load from 1877 to July, 1881, was $67.50. It was then reduced to $60, but was advanced to $65, remaining at that figure from 1883 to 1887. It is now twenty-three and a half cents per hundred pounds, which is equivalent to $56.40 per car load. The rate on packed meats from Cincinnati to New York city averaged seventy-one and a quarter cents per hundred pounds during 1867; during 1877 the average was 31·93 cents; during 1887, 27·12 cents; and during 1893, 25·43 cents.

Turning to passenger traffic, it is found that the tendency toward increased speed and improved facilities has operated as a limitation upon reductions in charges, though by no means wholly preventing them. The earliest available data give the average charge per passenger per mile during the year 1880 as 2·51 cents, which is higher than any subsequent year. The average for 1893 was 1·976 cents, and the saving upon the traffic of that year over what the public would have paid at the higher rates of 1880 amounted to $80,568,025.

Numerous reductions equal to those given could be cited and to enumerate them all would require a statement showing rates between practically all railway stations and upon nearly every article commonly offered for shipment by rail. As such a mass

of detail would be unnecessarily confusing, it is important to endeavor to discover some means for measuring at least with approximate accuracy the aggregate public saving by means of reduced charges for railway transportation. Fortunately, we have such a means which may be made highly satisfactory so far, at least, as relates to the last decade. The entire transportation performed by the railways of the United States during the ten years ending on June 30, 1893, was equal to moving 113,170,723,026 passengers and 681,500,465,282 tons of freight one mile; and had the average rates of 1883 been maintained upon this aggregate, the public would have paid $251,981,813 for passenger and $1,797,078,221 for freight transportation more than was actually received by the railways. The total sum gained by the public by means of reduced charges was therefore $2,049,060,034, an amount equal to one fifth of the present aggregate railway capital, and almost exactly equal to the entire revenue the United States Government derived from customs duties during the same period.

The effect of the decline in the amounts received for similar railway service upon railway revenues can not be neglected by intelligent students of transportation. The following comparisons between the years 1871, 1882, and 1893 are therefore presented:

	PER MILE OF LINE OPERATED.		
	1871.	1882.	1893.
Capitalization—stock and bonds	$59,426	$61,969	$59,729
Gross earnings	9,040	7,189	7,190
Operating expenses	6,863	4,290	4,876
Net earnings	3,177	2,899	2,314
Freight earnings	6,600	4,725	4,883
Passenger earnings	2,441	1,886	1,776
Dividends	1,265	952	594

From the foregoing it is seen that the average railway capitalization has changed but little. Gross earnings per mile decreased during the first half of the period, but have remained without material change during the last; or, in other words, the increased traffic has so far balanced the decrease in charges that the average gross revenue has not changed. Operating expenses have increased during the last eleven years, though during the period from 1871 to 1882 they showed a decline. The explanation is, that during the first period increased density of traffic permitted economies in conducting transportation which had the effect of reducing the average cost to the carriers. It would appear, however, that a point was reached beyond which the institution of new economies could not keep pace with increased traffic at low rates, and that this had its natural effect in the second period. This explanation gains force when the constant decrease in average net earnings per mile is noted. Average freight

and passenger earnings are seen to have fallen off considerably since 1871, and the final effect of these changes is summarized by the item of dividends, which are seen to be less than fifty per cent of those paid during 1871.

The more complete statistics of the last ten years afford still more impressive results. The following data are for the year ending on June 30, 1893, and comparisons by means of percentages with 1884 are given:

	1893.	COMPARED WITH 1884.	
		Increase, per cent.	Decrease, per cent.
Tons of freight carried one mile	93,588,111,833	109·25	
Average rate per ton per mile	0·878 cent	.....	21·96
Freight revenue	$829,053,861	63·55	
Passengers carried one mile	14,229,101,084	62·09	
Average rate per passenger per mile	2·108 cents	.....	10·53
Passenger revenue	$301,491,816	44·74	
Operating expenses	$827,921,299	64·72	
Net earnings	$392,830,575	46·54	
Dividends	$100,929,885	.....	1·10

It is thus seen that more than double the freight transportation of 1884 is now performed for a total compensation less than two thirds greater; that passenger transportation has increased eighteen per cent more than the sum paid therefor; and that the capital now invested in the stock of one hundred and seventy-six thousand miles of railway receives in dividends a sum absolutely less than did that invested in the one hundred and twenty-five thousand miles operated during 1884. These figures furnish a key to the reasons which justified Judge Cooley's epigrammatic summary of the financial condition of the railway interest when he declared that it "represents an enormous aggregate of wealth and an increasing aggregate of corporate poverty."

The natural query is, What is to be the result? Are railway rates to go still lower, and the return to invested capital become even less than at present; or are charges to remain stationary, and the public benefit from cheapening transportation be finally or even temporarily suspended?

Probably the best informed among railway managers would declare that their charges are already too low, and that it is highly important to discover some means for preventing further reductions. As to what means would safely accomplish this result there is great diversity of opinion, and not a few managers whose knowledge of the conditions governing the business of transportation has accrued during long years of practical experience are emphatic in the announcement of their belief that the tendency toward lower charges is the result of commercial laws which they have no power to restrain. If the latter opinion is the cor-

rect one, as may reasonably be assumed from the history of railway transportation, as well as from a consideration of the competition to which rail carriers are everywhere subject, not only among themselves but from common carriers operating *via* our rivers and lakes, and of the recent impetus which has been given to the construction of artificial waterways by the completion of the Manchester Canal, it is necessary to discover means for further reducing charges without at the same time decreasing net revenue so as to ultimately result in deterioration and bankruptcy of the railways. Obviously, the return to capital must not be much further reduced. With a large portion of the railways of the country in the hands of receivers, the securities of nearly all selling lower than ever before, and being returned in larger quantities from European exchanges, it is evident that the door to further reductions at the expense of capital is closed. Railway transportation, then, must become cheaper by reducing its cost to the corporations conducting it; and as it has been shown that operating expenses per mile of line have increased during the past decade, while gross revenue has remained practically stationary, it is apparent that this can only be accomplished through the introduction of economies not now practiced.

These economies, the nature of which is evident to every experienced railway manager and every intelligent student of transportation, can be effected by the actual or tacit consolidation of railway properties, and their extent and importance will be in direct ratio to the thoroughness of the consolidation and the degree in which the conflicting interests are brought into subjection. The wastes of competition are nowhere more evident nor their detrimental effect upon society as a whole more clearly apparent than in railway transportation.

The legislative restraints upon consolidation should be removed, agreements and contracts between common carriers where not in contravention of public policy should be given legal sanction, in order that the products of farms and factories may be distributed and exchanged at lower cost and with greater freedom. If necessary, the means of governmental regulation should be strengthened, and the operation of the consolidated properties brought more in harmony with public interests. If, as a final result, it should appear that absolute government ownership is safe, practicable, and likely to be productive of much good, it is not unduly optimistic confidently to expect that our institutions will be found perfectly adequate for the new task, and it will certainly be found much easier to deal with a few large corporations than with the multitude of smaller ones now in existence.

PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

V.—IN SUMMER STAR-LANDS.

IN the soft air of a summer night, when fireflies are flashing their lanterns over the fields, the stars do not sparkle and blaze like those that pierce the frosty skies of winter. The light of Sirius, Aldebaran, Rigel, and other midwinter brilliants possesses a certain gemlike hardness and cutting quality, while Antares and Vega, the great summer stars, and Arcturus, when he hangs westering in a July night, exhibit a milder radiance, according with the character of the season. This difference is, of course, atmospheric in origin, although it may be partly subjective, depending upon the mental influences of the mutations of Nature.

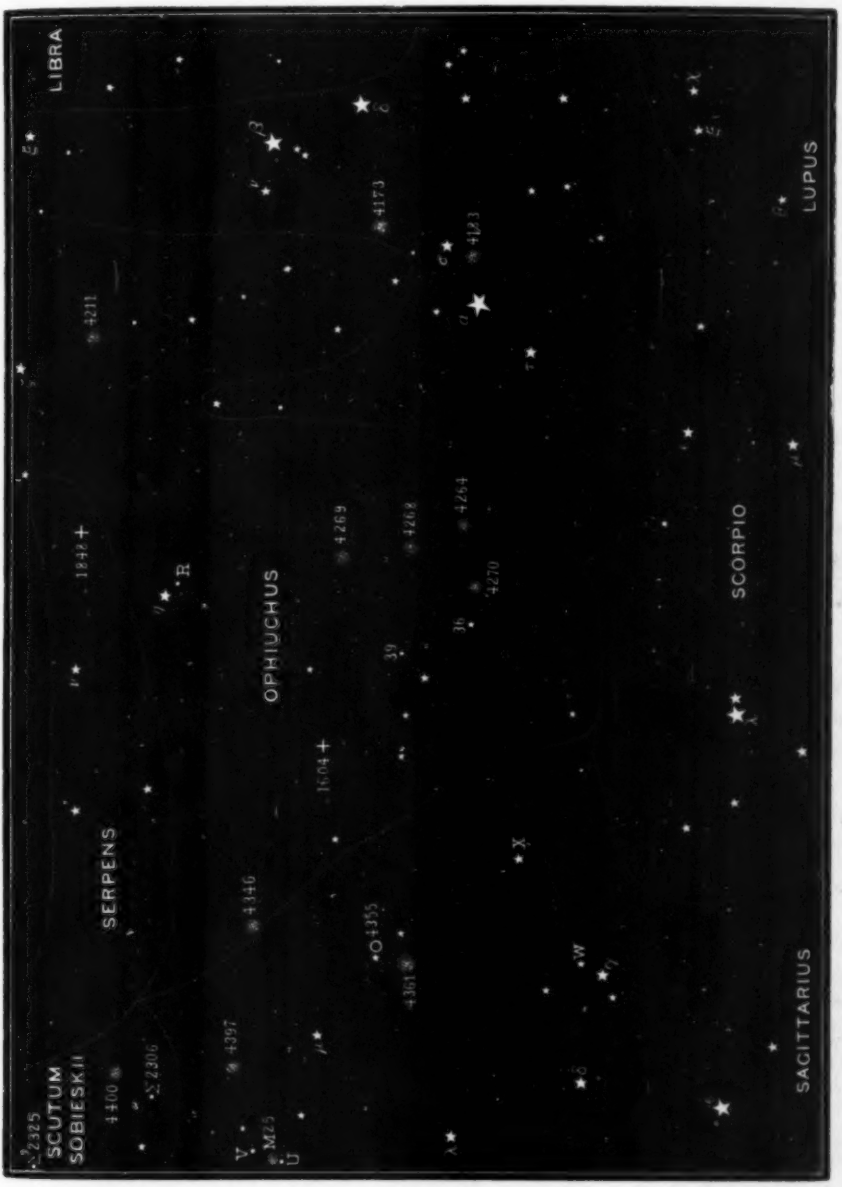
The constellation Scorpio is nearly as striking in outline as Orion, and its brightest star, the red Antares (α in map No. 12), carries concealed in its rays a green jewel which, to the eye of the enthusiast in telescopic recreation, appears more beautiful and inviting each time that he penetrates to its hiding place.

We shall begin our night's work with this object, and the four-inch glass will serve our purpose, although the untrained observer would be more certain of success with the five-inch. A friend of mine has seen the companion of Antares with a three-inch, but I have never tried the star with so small an aperture. When the air is steady and the companion can be well viewed, there is no finer sight among the double stars. The contrast of colors is beautifully distinct—fire-red and bright green. The little green star has been seen emerging from behind the moon, after an occultation, ahead of its ruddy companion. The magnitudes are one and seven and a half or eight; distance 3″, p. 270°. Antares is probably a binary, although its binary character has not yet been established.

A slight turn of the telescope tube brings us to the star σ, a wide double, the smaller component of which is blue or plum-colored; magnitudes four and nine, distance 20″, p. 272°. From σ we pass to β, a very beautiful object, of which the three-inch gives us a splendid view. Its two components are of magnitudes two and six; distance 13″, p. 30°; colors, white and bluish. It is interesting to know that the larger star is itself double, although none of the telescopes we are using can split it. Burnham discovered that it has a tenth-magnitude companion; distance less than 1″, p. 87°.

And now for a triple, which will probably require the use of our largest glass. Up near the end of the northern prolongation

of the constellation we perceive the star ξ. The three-inch shows us that it is double; the five-inch divides the larger star again. The magnitudes are respectively five, five and a half, and seven and a half; distances 1·23″, p. 208°, and 7″, p. 70°.



Map No. 12.

A still more remarkable star, although one of its components is beyond our reach, is ν. With the slightest magnifying this object splits up into two stars, of magnitudes four and seven,

situated rather more than 40″ apart. A high power divides the seventh-magnitude companion into two, each of magnitude six and a half; distance 1·8″, p. 42°. But (and this was another of Burnham's discoveries) the fourth-magnitude star itself is double; distance 0·8″, p. about 0°. The companion in this case is of magnitude five and a half.

Next we shall need a rather low-power eyepiece and our largest aperture in order to examine a star cluster, No. 4173, which was especially admired by Sir William Herschel, who discovered that it was not, as Messier had supposed, a circular nebula. Herschel regarded it as the richest mass of stars in the firmament, but with a small telescope it appears merely as a filmy speck that has sometimes been mistaken for a comet. In 1860 a new star, between the sixth and seventh magnitude in brilliance, suddenly appeared directly in or upon the cluster, and the feeble radiance of the latter was almost extinguished by the superior light of the stranger. The latter disappeared in less than a month, and has not been seen again, although it is suspected to be a variable, and, as such, has been designated with the letter T. Two other known variables. both very faint, exist in the immediate neighborhood. According to the opinion that has generally been looked upon with favor, the variable T, if it is a variable, simply lies in the line of sight between the earth and the star cluster, and has no actual connection with the latter. But this opinion may not, after all, be correct. The cluster 4183, just west of Antares, is also worth a glance with the five-inch glass. It is dense, but its stars are very small, so that to enjoy its beauty we should have to employ a large telescope. Yet there is a certain attraction in those far-away glimpses of starry swarms, for they give us some perception of the awful profundity of space. When the mind is rightly attuned for these revelations of the telescope, there are no words that can express its impressions of the overwhelming perspective of the universe.

The southern part of the constellation Ophiuchus is almost inextricably mingled with Scorpio. We shall, therefore, look next at its attractions, beginning with the remarkable array of star clusters 4264, 4268, 4269, and 4270. All of these are small, 2′ or 3′ in diameter, and globular in shape. No. 4264 is the largest, and we can see some of the stars composing it. But these clusters, like those just described in Scorpio, are more interesting for what they mean than for what they show; and the interest is not diminished by the fact that their meaning is more or less of a mystery. Whether they are composed of pygmy suns or of great solar globes like that one which makes daylight for the earth, their association in spherical groups is equally suggestive.

There are two other star clusters in Ophiuchus, and within the

limits of map No. 12, both of which are more extensive than those we have just been looking at. No. 4211 is 5′ or 6′ in diameter, also globular, brighter at the center, and surrounded by several comparatively conspicuous stars. No. 4346 is still larger, about half as broad as the moon, and many of its scattered stars are of not less than the ninth magnitude. With a low magnifying power the field of view surrounding the cluster appears powdered with stars.

There are only two noteworthy doubles in that part of Ophiuchus with which we are at present concerned: 36, whose magnitudes are five and seven, distance 4·3″, p. 195°, colors yellow and red; and 39, magnitudes six and seven and a half, distance 12″, p. 356°, colors yellow or orange and blue. The first named is a binary whose period has not been definitely ascertained.

The variable R has a period a little less than three hundred and three days. At its brightest it is of magnitude seven or eight, and at minimum it diminishes to about the twelfth magnitude.

The spot where the new star of 1604 appeared is indicated on the map. This was, with the exception of Tycho's star in 1572, the brightest temporary star of which we possess a trustworthy account. It is frequently referred to as Kepler's star, because Kepler watched it with considerable attention, but unfortunately he was not as good an observer as Tycho was. The star was first seen on October 10, 1604, and was then brighter than Jupiter. It did not, however, equal Venus. It gradually faded and in March, 1606, disappeared. About twelve degrees northwest of the place of the star of 1604, and in that part of the constellation Serpens which is included in map No. 12, we find the location of another temporary star, that of 1848. It was first noticed by Mr. Hind on April 28th of that year, when its magnitude was not much above the seventh, and its color was red. It brightened rapidly, until on May 2d it was of magnitude three and a half. Then it began to fade, but very slowly, and it has never entirely disappeared. It is now of the twelfth or thirteenth magnitude.

In passing we may glance with a low power at ν Serpentis, a wide double, magnitudes four and nine, distance 50″, p. 31°, colors contrasted but uncertain.

Sagittarius and its neighbor, the small but rich constellation Scutum Sobieskii, attract us next. We shall first deal with the western portions of these constellations which are represented on Map No. 12. The star μ in Sagittarius is a wide triple, magnitudes three and a half, nine and a half, and ten, distances 40″, p. 315°, and 45″, p. 114°. But the chief glory of Sagittarius (and the same statement applies to Scutum Sobieskii) lies in its assemblage of star clusters. One of these, No. 4361, also known as M 8, is plainly visible to the naked eye as a bright spot in the Milky Way.

We turn our five-inch telescope, armed with a low magnifying power, upon this object and enjoy a rare spectacle. As we allow it to drift through the field we see a group of three comparatively brilliant stars advancing at the front of a wonderful train of mingled star clusters and nebulous clouds. A little northwest of it appears the celebrated trifid nebula, No. 4355 on the map. There is evidence that changes have occurred in this nebula since its discovery in the last century. Barnard has made a beautiful photograph showing M 8 and the trifid nebula on the same plate, and he remarks that the former is a far more remarkable object than its more famous neighbor. Near the eastern border of the principal nebulous cloud there is a small and very black hole with a star poised on its eastern edge. This hole and the star are clearly shown in the photograph.

Cluster No. 4397 (M 24) is usually described as resembling, to the naked eye, a protuberance on the edge of the Milky Way. It is nearly three times as broad as the moon, and is very rich in minute stars, which are just at that degree of visibility that crowds of them are continually appearing and disappearing while the eye wanders over the field, just as faces are seen and lost again in a vast assemblage of people. This kind of luminous agitation is not peculiar to M 24, although that cluster exhibits it better than most others do on account both of the multitude and the minuteness of its stars.

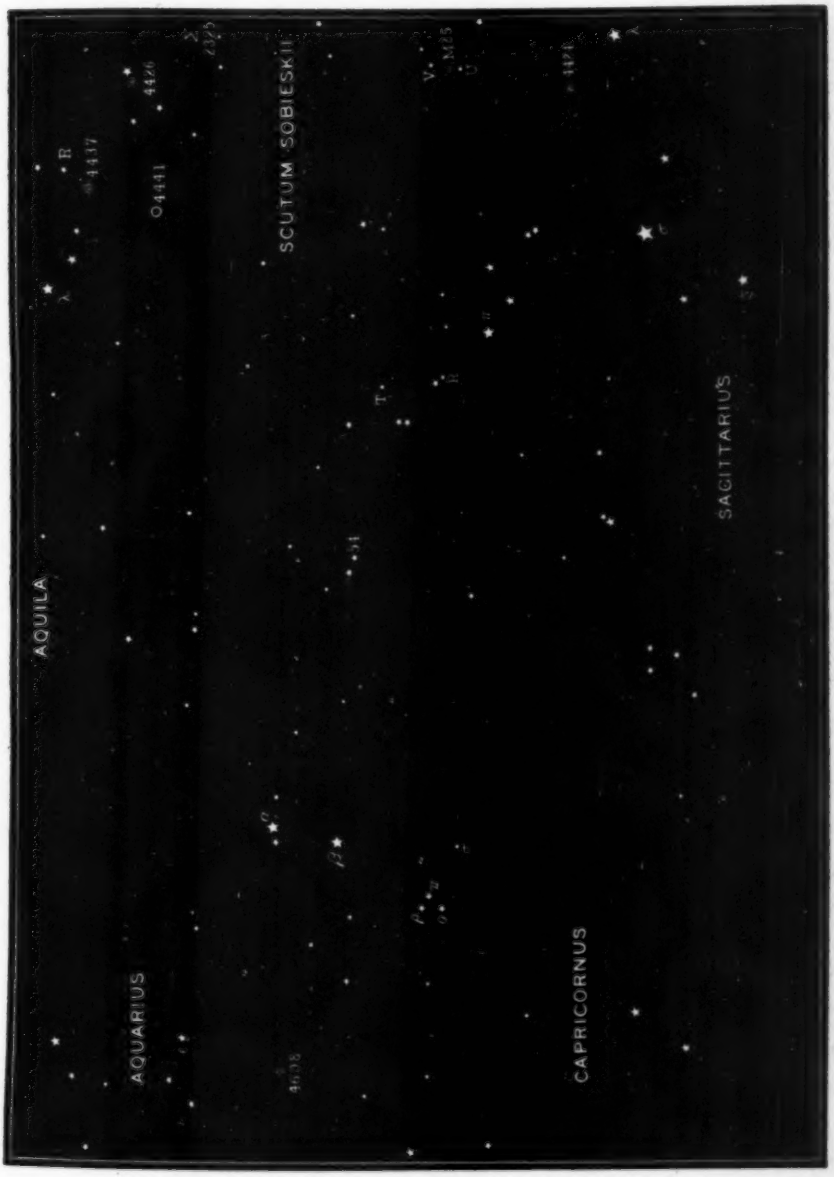
A slight sweep eastward brings us to yet another meeting place of stars, the cluster M 25, situated between the variables U and V. This is brilliant and easily resolved into its components, which include a number of double stars.

The two neighboring variables just referred to are interesting. U has a period of about six days and three-quarters, and its range of magnitude runs from the seventh down to below the eighth. V is a somewhat mysterious star. Chandler removed it from his catalogue of variables because no change had been observed in its light by either himself, Sawyer, or Yendell. Quirling, the discoverer of its variability, gave the range as between magnitudes 7·6 and 8·8. It must, therefore, be exceedingly erratic in its changes, resembling rather the temporary stars than the true variables.

In that part of Scutum Sobieskii contained in map No. 12 we find an interesting double, Σ 2325, whose magnitudes are six and nine, distance 12·3″, p. 260°, colors white and orange. Σ 2306 is a triple, magnitudes seven, eight, and nine, distances 12″, p. 220°, and 0·8″, p. 68°. The third star is, however, beyond our reach. The colors of the two larger are respectively yellow and violet.

The star cluster 4400 is about one quarter as broad as the moon, and easily seen with our smallest aperture.

Passing near to the region covered by map No. 13, we find the remaining portions of the constellations Sagittarius and Scutum Sobieskii. It will be advisable to finish with the latter first.



MAP No. 18.

Glance at the clusters 4426 and 4437. Neither is large, but both are rich in stars. The nebula 4441 is a fine object of its kind. It brightens toward the center, and Herschel thought he had resolved it into stars. The variable R is remarkable for its eccen-

tricities. Sometimes it attains nearly the fourth magnitude, although usually at maximum it is below the fifth, while at minimum it is occasionally of the sixth and at other times of the seventh or eighth magnitude. Its period is irregular.

Turning back to Sagittarius, we resume our search for interesting objects there, and the first that we discover is another star cluster, for the stars are wonderfully gregarious in this quarter of the heavens. The number our cluster bears on the map is 4424, corresponding with M 22 in Messier's catalogue. It is very bright, containing many stars of the tenth and eleventh magnitudes, as well as a swarm of smaller ones. Sir John Herschel regarded the larger stars in this cluster as possessing a reddish tint. Possibly there was some peculiarity in his eye that gave him this impression, for he has described a cluster in the constellation Toucan in the southern hemisphere as containing a globular mass of rose-colored stars inclosed in a spherical shell of white stars. Later observers have confirmed his description of the shape and richness of this cluster in Toucan, but have been unable to perceive the red hue of the interior stars.

The eastern expanse of Sagittarius is a poor region compared with the western end of the constellation, where the wide stream of the Milky Way like a great river enriches its surroundings. The variables T and R are of little interest to us, for they never become bright enough to be seen without the aid of a telescope. In 54 we find, however, an interesting double, which with larger telescopes than any of ours appears as a triple. The two stars that we see are of magnitudes six and seven and a half; distance 45″, p. 42°, colors yellow and blue. The third star, perhaps of thirteenth magnitude, is distant 36″, p. 245°.

Retaining map No. 13 as our guide, we examine the western part of the constellation Capricornus. Its leader α is a naked-eye double, the two stars being a little more than 6′ apart. Their magnitudes are three and four, and both have a yellowish hue. The western star is α^1, and is the fainter of the two. The other is designated as α^2. Both are double. The components of α^1 are of magnitudes four and eight and a half; distance 44″, p. 220°. With the Washington twenty-six-inch telescope a third star of magnitude fourteen has been found at a distance of 40″, p. 182°. In α^2 the magnitudes of the components are three and ten and a half; distance 7·4″, p. 150°. The smaller star has a companion of the twelfth or thirteenth magnitude; distance 1·2″, p. 240°. This, of course, is hopelessly beyond our reach. Yet another star of magnitude nine, distance 154″, p. 156°, we may see easily.

Dropping down to β, we find it to be a most beautiful and easy double, possessing finely contrasted colors, gold and blue. The larger star is of magnitude three, and the smaller, the

blue one, of magnitude six; distance 205″, p. 267°. Between them there is a very faint star which larger telescopes than ours divide into two, each of magnitude eleven and a half; separated 3″, p. 325°.

Still farther south and nearly in a line drawn from α through β we find a remarkable group of double stars, σ, π, ρ, and o. The last three form a beautiful little triangle. We begin with σ, the faintest of the four. The magnitudes of its components are six and nine; distance 54″, p. 177°. In π the magnitudes are five and nine, distance 3·4″, p. 145°; in ρ, magnitudes five and eight, distance 3·8″, p. 177° (a third star of magnitude seven and a half is seen at a distance of 4′, p. 150°); in o, magnitudes six and seven, distance 22″, p. 240°.

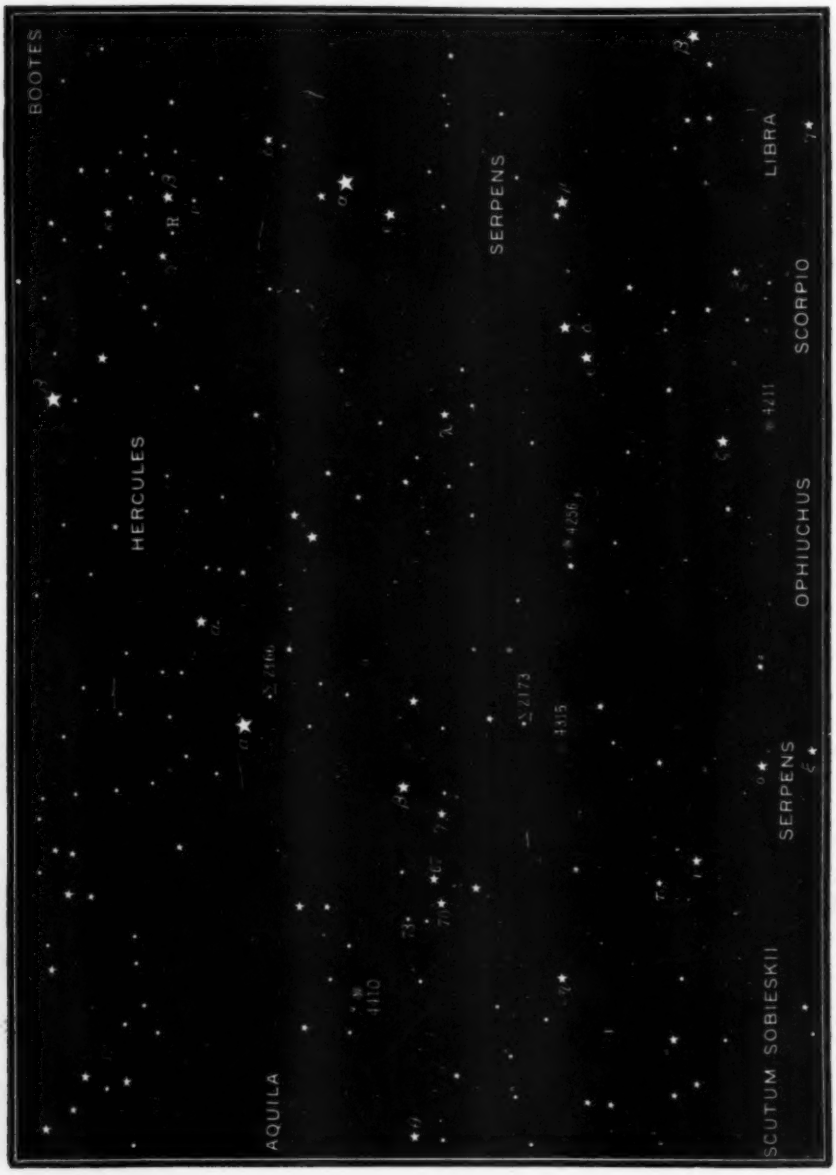
The star cluster 4608 is small, yet, on a moonless night, worth a glance with the five-inch.

We now pass northward to the region covered by map No. 14, indluding the remainder of Ophiuchus and Serpens. Beginning with the head of Serpens, in the upper right-hand corner of the map, we find that β, of magnitude three and a half, has a ninth-magnitude companion, distance 30″, p. 265°. The larger star is light blue and the smaller one yellowish. The little star ν is double, magnitudes five and nine, distance 50″, p. 31°, colors contrasted but uncertain. In δ we find a closer double, magnitudes three and four, distance 3·5″, p. 190°. It is a beautiful object for the three-inch. The leader of the constellation, α, of magnitude two and a half, has a faint companion of only the twelfth magnitude, distance 60″, p. 350°. The small star is bluish. The variable R has a period about a week short of one year, and at maximum exceeds the sixth magnitude, although sinking at minimum to less than the eleventh. Its color is ruddy.

Passing eastward, we come again into Ophiuchus, and find immediately the very interesting double, λ, whose components are of magnitudes four and six, distance 1·2″, p. 45°. This is a long-period binary, and, notwithstanding the closeness of its stars, our four-inch should separate them when the seeing is fine. We shall do better, however, to try with the five-inch. Σ 2166 consists of two stars of magnitudes six and seven and a half, distance 27″, p. 280°. Σ 2173 is a double of quite a different order. The magnitudes of its components are both six, the distance in 1894 1·14″, p. 357°. It is evidently a binary in rapid motion, as the distance changed from about a quarter of a second in 1881 to more than a second in 1894. The star τ is a fine triple, magnitudes five, six, and nine, distances 1·8″, p. 254°, and 100″, p. 127°. The close pair is a binary system with a long period of revolution, estimated at about two hundred years. We discover another group of remarkable doubles in 67, 70, and 73. In the first-named star the magnitudes are four

and eight, distance 55″, p. 144°, colors finely contrasted, pale yellow and red.

Much more interesting, however, is 70, a binary whose components have completed a revolution since their discovery by Sir



Map No. 14.

William Herschel, the period being ninety-five years. The magnitudes are four and six, or, according to Hall, five and six, distance in 1894 2·3″. Hall says the apparent distance when the stars

are closest is about 1·7″, and when they are widest 6·7″. This star is one of those whose parallax has been calculated with a reasonable degree of probable accuracy. Its distance from us is about 1,260,000 times the distance of the sun, the average distance apart of the two stars is about 2,800,000,000 miles (equal to the distance of Neptune from the sun), and their combined mass is three times that of the sun. Hall has seen in the system of 70 Ophiuchi three stars of the thirteenth magnitude or less, at distances of about 60″, 90″, and 165″ respectively.

The star 73 is also a close double, and beyond our reach. Its magnitudes are six and seven, distance 0·7″, p. 245°. It is, no doubt, a binary.

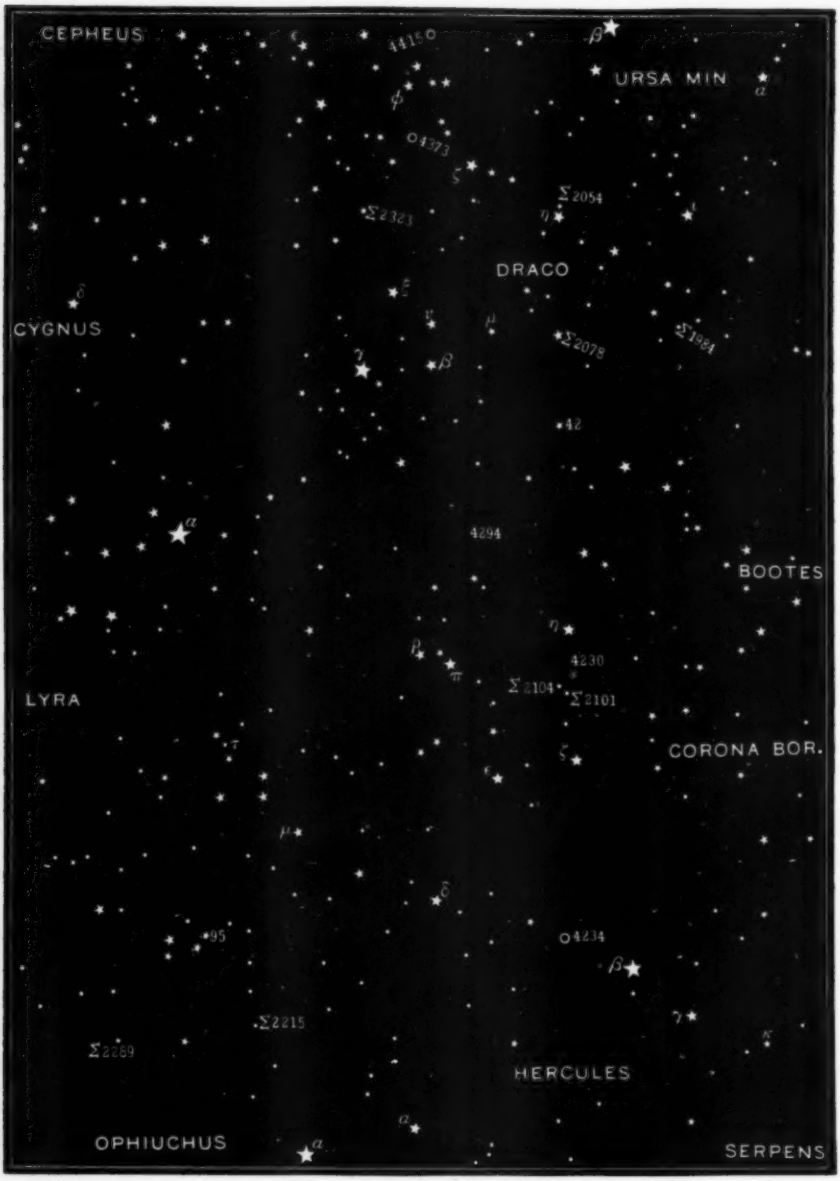
Three star clusters in Ophiuchus remain to be examined. The first of these, No. 4256, is partially resolved into stars by the five-inch. No. 4315 is globular, and has a striking environment of by-standing stars. It is about one quarter as broad as the full moon, and our largest aperture reveals the faint coruscation of its crowded components. No. 4410 is a coarser and more scattered star swarm—a fine sight.

Farther toward the east we encounter a part of Serpens again, which contains just one object worth glancing at, the double θ, whose stars are of magnitudes four and four and a half, distance 21″, p. 104°. Color, both yellow, the smaller star having the deeper hue.

Let us next, with the guidance of map No. 15, enter the rich star fields of Hercules, and of the head and first coils of Draco. According to Argelander, Hercules contains more stars visible to the naked eye than any other constellation, and he makes the number of them one hundred and fifty-five, nearly two thirds of which are only of the sixth magnitude. But Heis, who saw more naked-eye stars than Argelander, makes Ursa Major precisely equal to Hercules in the number of stars, his enumeration showing two hundred and twenty-seven in each constellation, while, according to him, Draco follows very closely after, with two hundred and twenty stars. Yet, on account of the minuteness of the majority of their stars, neither of these constellations makes by any means as brilliant a display as does Orion, to which Argelander assigns one hundred and fifteen naked-eye stars, and Heis one hundred and thirty-six.

We begin in Hercules with the star κ, a pretty little double of magnitudes five and a half and seven, distance 31″, p. 10°, colors yellow and red. Not far away we find, in γ, a larger star with a fainter companion, the magnitudes in this case being three and a half and nine, distance 38″, p. 242°, colors white and faint blue or lilac. One of the most beautiful of double stars is α Herculis. The magnitudes are three and six, distance 4·7″, p. 118°, colors

orange and green, very distinct. Variability has been ascribed to each of the stars in turn. It is not known that they constitute a binary system, because no certain evidence of motion has been ob-



Map No. 15.

tained. Another very beautiful and easily separated double is δ, magnitudes three and eight, distance 19″, p. 175°, colors pale green and purple.

Sweeping northwestward to ζ, we find a celebrated binary, to separate which will require the higher powers of our five-inch glass. The magnitudes are three and six and a half, distance in 1894 1·28″, p. 40°. The period of revolution is thirty-five years, and two complete revolutions have been observed. The apparent distance changes from 0·6″ to 1·6″. They were at their extreme distance in 1884 and are now closing.

Two pleasing little doubles are Σ 2101, magnitudes six and nine, distance 4″, p. 57°, and Σ 2104, magnitudes six and eight, distance 6″, p. 20°. At the northern end of the constellation is 42, a double that requires the light-grasping power of our largest glass. Its magnitudes are six and twelve, distance 20″, p. 94°. In ρ we discover another distinctly colored double, both stars being greenish or bluish, with a difference of tone. The magnitudes are four and five and a half, distance 3·7″, p. 309°. But the double 95 is yet more remarkable for the colors of its stars. Their magnitudes are five and five and a half, distance 6″, p. 262°, colors, according to Webb, "light apple-green and cherry-red." But other observers have noted different hues, one calling them both golden yellow. I think Webb's description is more nearly correct. Σ 2215 is a very close double, requiring larger telescopes than those we are working with. Its magnitudes are six and a half and eight, distance 0·7″, p. 300°. It is probably a binary. Σ 2289 is also close, but our five-inch will separate it: magnitudes six and seven, distance 1·2″, p. 230°.

Turning to μ, we have to deal with a triple, one of whose stars is at present beyond the reach of our instruments. The magnitudes of the two that we see are four and ten, distance 31″, p. 243°. The tenth-magnitude star is a binary of short period (probably less than fifty years), the distance of whose components was 2″ in 1859, 1″ in 1880, 0·34″ in 1889, and 0·54″ in 1891, when the position angle was 25°, and rapidly increasing. The distance is still much less than 1″.

For a glance at a planetary nebula we may turn with the five-inch to No. 4234. It is very small and faint, only 8″ in diameter, and equal in brightness to an eighth-magnitude star. Only close gazing shows that it is not sharply defined like a star, and that it possesses a bluish tint. Its spectrum is gaseous.

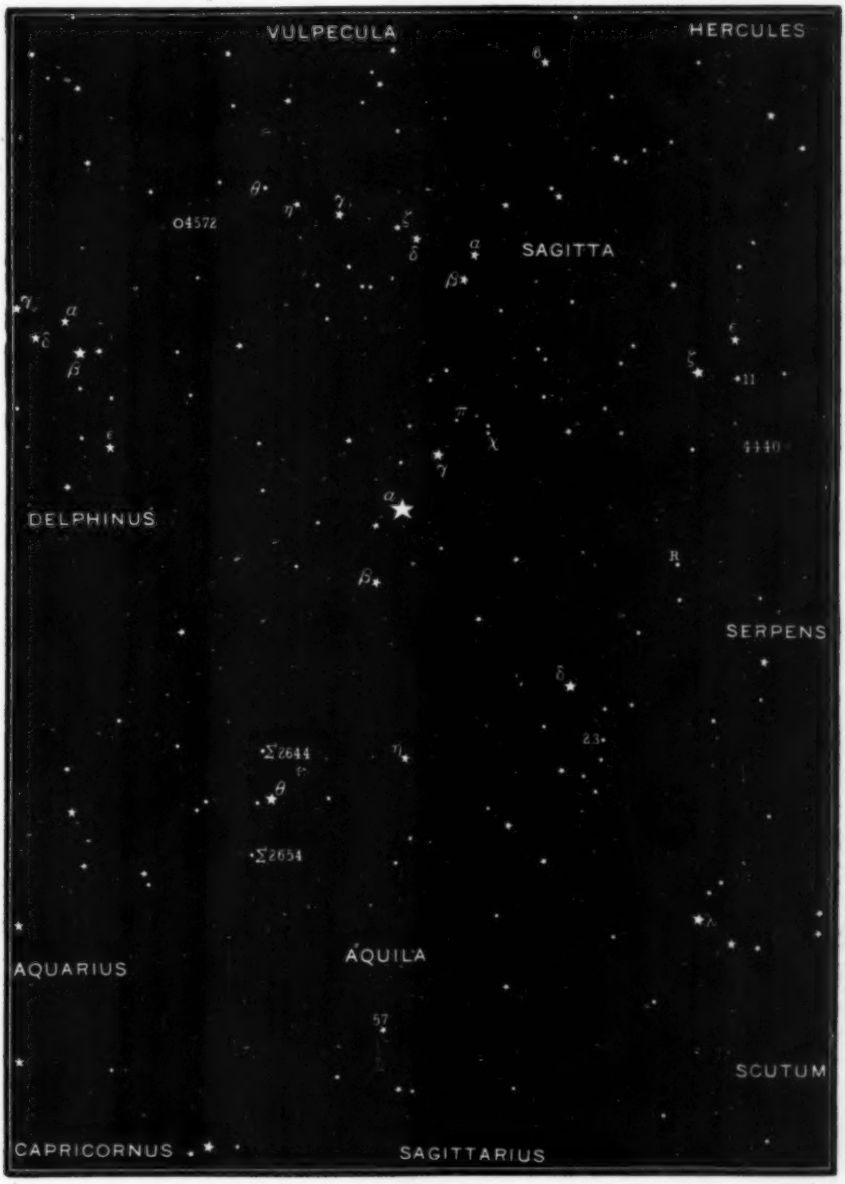
The chief attraction of Hercules we have left for the last, the famous star cluster between η and ζ, No. 4230, more commonly known as M 13. On a still evening in the early summer, when the moon is absent and the quiet that the earth enjoys seems an influence descending from the brooding stars, the spectacle of this sun cluster in Hercules, viewed with a telescope of not less than five-inches aperture, captivates the mind of the most uncontemplative observer. With the Lick telescope I have watched it

resolve into separate stars to its very center—a scene of marvelous beauty and impressiveness. But smaller instruments reveal only the in-running star streams and the sprinkling of stellar points over the main aggregation, which cause it to sparkle like a cloud of diamond dust transfused with sunbeams. The appearance of flocking together that those uncountable thousands of stars present calls up at once a picture of our lone sun separated from its nearest stellar neighbor by a distance probably a hundred times as great as the entire diameter of the spherical space within which that multitude is congregated. It is true that unless we assume what would seem an unreasonable remoteness for the Hercules cluster, its component stars must be much smaller bodies than the sun; yet even that fact does not diminish the wonder of their swarming. Here the imagination must bear science on its wings, else science can make no progress whatever.

It is an easy step from Hercules to Draco. In the conspicuous diamond-shaped figure that serves as a guideboard to the head of the latter, the southernmost star belongs not to Draco but to Hercules. The brightest star in this figure is γ, of magnitude two and a half, with an eleventh-magnitude companion, distant 125″, p. 116°. Two stars of magnitude five compose ν, their distance apart being 62″, p. 312°. A more interesting double is μ, magnitudes five and five, distance 2·4″, p. 158°. Both stars are white, and they present a pretty appearance when the air is steady. They form a binary system of unknown period. Σ 2078 (also called 17 Draconis) is a triple, magnitudes six, six and a half, and six, distances 3·8″, p. 116°, and 90″, p. 195°. Σ 1984 is an easy double, magnitudes six and a half and eight and a half, distance 6·4″, p. 276°. The star η is a very difficult double for even our largest aperture, on account of the faintness of one of its components. The magnitudes are two and a half and ten, distance 4·7″, p. 140°. Its near neighbor, Σ 2054, may be a binary. Its magnitudes are six and seven, distance 1″, p. 0°. In Σ 2323 we have another triple, magnitudes five, eight and a half, and seven, distances 3·6″, p. 360°, and 90″, p. 22°, colors white, blue, and reddish. A fine double is ϵ, magnitudes five and eight, distance 3″, p. 5°.

The nebula No. 4373 is of a planetary character, and interesting as occupying the pole of the ecliptic. A few years ago Dr. Holden, with the Lick telescope, discovered that it is unique in its form. It consists of a double spiral, drawn out nearly in the line of sight, like the thread of a screw whose axis lies approximately endwise with respect to the observer. There is a central star, and another fainter star is involved in the outer spiral. The form of this object suggests strange ideas as to its origin. But the details mentioned are far beyond the reach of our instruments.

We shall only see it as a hazy speck. No. 4415 is another nebula worth glancing at. It is Tuttle's so-called variable nebula.



Map No. 16.

There are three constellations represented on map No. 16 to which we shall pay brief visits. First Aquila demands attention. Its doubles may be summarized as follows: 11, magnitudes five and nine, distance 17·4″, p. 252°; π, magnitudes six and seven, dis-

tance 1·6″, p. 122°; 23, magnitudes six and ten, distance 3·4″, p. 12°—requires the five-inch and good seeing; 57, magnitudes five and six, distance 36″, p. 170°; Σ 2654, magnitudes six and eight, distance 12″, p. 234°; Σ 2644, magnitudes six and seven, distance 3·6″, p. 208°.

The star η is an interesting variable between magnitudes three and a half and 4·7; period, seven days, four hours, fourteen minutes. The small red variable R changes from magnitude six to magnitude seven and a half and back again in a period of three hundred and fifty-one days.

Star cluster No. 4440 is a very striking object, its stars ranging from the ninth down to the twelfth magnitude.

Just north of Aquila is the little constellation Sagitta, containing several interesting doubles and many fine star fields, which may be discovered by sweeping over it with a low-power eyepiece. The star ζ is double, magnitudes five and nine, distance 8·6″, p. 312°. The larger star is itself double, but far too close to be split, except with very large telescopes. In θ we find three components of magnitudes seven, nine, and eight respectively, distances 11·4″, p. 327°, and 70″, p. 227°. A wide double is ϵ, magnitudes six and eight, distance 92″, p. 81°. Nebula No. 4572 is planetary.

Turning to Delphinus, we find a very beautiful double in γ, magnitudes four and five, distance 11″, p. 273°, colors golden and emerald. The leader α, which is not as bright as its neighbor β, and which is believed to be irregularly variable, is of magnitude four, and has a companion of nine and a half magnitude at the distance 35″, p. 278°. At a similar distance, 35″, p. 335°, β has an eleventh-magnitude companion, and the main star is also double, but excessively close, and much beyond our reach. It is believed to be a swiftly moving binary, whose stars are never separated widely enough to be distinguished with common telescopes.

In the studies of Raoul Pictet and Altschul on phosphorescence at very low temperatures, glass tubes containing sulphides of calcium, strontium, and barium, exposed to sunlight for periods that were noted, were plunged into liquid nitrous oxide, the temperature of which, by rapid diminution of pressure, could be brought to — 140° C. After twelve minutes' immersion the tubes were brought into a dark room and their behavior was carefully observed. At first, no indication of phosphorescence could be observed. In a few moments the upper part of the tube, which had not been so strongly cooled as the rest, began to phosphoresce, and gradually the feeble light seemed to spread itself down the tube, the lower part of which, however, glowed more feebly than the upper. After five minutes the tubes acquired their ordinary vivid color, without subsequent exposure to sunlight or even to diffused daylight. All phosphorescent substances appeared to behave in this way.

THE PSYCHOLOGY OF WOMAN.

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EVERY thoughtful observer of both the popular and the scientific movements of the day must have noticed the frequent lack of harmony or co-operation between them. Such lack of co-operation, if not of harmony, is well illustrated in the woman question. Two vigorous movements are now in progress. The first is a popular movement, whose end, apparently being very rapidly realized, is the advancement of woman to a position of complete political, legal, educational, and social parity with man —a position which means much more than mere equality of rights for woman; it means for her a changed sphere of activity, with new duties and new burdens, and may in the end involve radical changes in the state and in the family. The second is a scientific movement in anthropology, conducted by laborious and painstaking research, whose end is to ascertain the constitutional differences, both physical and psychical, between man and woman. It may be that these two movements will be found to support each other; but, if so, it is to be feared that it will be by happy chance rather than by intelligent co-operation.

It is the purpose of this article to bring together some of the results of these anthropological studies relating especially to the psychology of woman, in order that we may see what bearing, if any, they may have upon the above-mentioned popular movement. The most devoted patron of woman's political and educational advancement would hardly deny that the success and permanence of the reform will depend in the end upon the fact that there shall be no inherent contradiction between her new duties and her natural physical and mental constitution. It should be borne in mind, however, that the mere fact of woman's present intellectual or physical weakness, should such be shown, would not be a justifiable ground for denying to her full political and educational privileges. It might be quite the reverse, if it should appear that such weakness were itself the result of the subordinate position which she has been compelled to hold. It would, however, be a justifiable ground for advising woman to assume her new duties gradually, in order that disaster to her cause might not follow the overtaxing of her strength.

In outlining some of the psychological peculiarities of woman as revealed by modern anthropological researches, I shall endeavor to confine myself to those points upon which investigators generally agree, simply omitting those still in dispute, or mentioning them only as questioned.

All facts are best studied in the light of an idea. It may be conducive to clearness, therefore, to mention first the leading theories now in the field concerning woman's peculiarities. It has often been asserted since Aristotle that woman is a stunted or inferior man and represents arrested development. Again, it has been said that woman is a grown-up child, that she belongs to the child type, and must ever to some extent retain the child relation. Again, more recently, it has been maintained that although woman belongs to the child type, yet the child type is in truth the race type and represents greater perfection than is represented by man, whose natural characteristic is senility. Finally, it has been said that throughout the whole animal world, where artificial circumstances have not modified natural relations, the female stands for physical superiority in size and vitality, and more truly represents the essential qualities of the species. Without prejudice for or against any of these theories, let us see what evidence there may be for each.

Psychology is no longer studied apart from physiology. We must therefore first notice some of the secondary sexual characteristics of woman in respect to her physical structure. Although we are chiefly concerned with the nervous system, a few other points may first be mentioned. Woman among all civilized races is both shorter and lighter than man, except at the age of thirteen or fourteen in our climate, when girls are both taller and heavier than boys of like age. Woman's form is more rounded and graceful, less bony and angular, having relatively more fat and less muscle. Her muscular tissue contains a slightly larger percentage of water. As shown by the dynamometer, woman's strength is at the most only about two thirds that of man, while her height is as sixteen to seventeen and her weight as nine to ten. In woman the trunk is, relatively to the length of the arms and legs, longer than in man. Owing to the greater inclination of the pelvis, woman is somewhat less erect than man. The head also is carried less upright, and the gait is comparatively unsteady and indirect. The greater length of the first finger as compared with the third is a feminine peculiarity. This relation, seldom found in man, is not uncommon among women. It gives grace to the hand, and would seem to be an instance of higher evolution, not being found among apes or savages. The vocal cords in woman are shorter and the voice is higher and shriller. The larynx is smaller and higher in the throat. The thyroid gland is considerably larger than in man. It is thought that women in respect to hair and eyes are slightly darker than men, but this has not been verified. Woman's lung capacity is in proportion to her size much less than man's, and the amount of carbonic acid expired is relatively less. Differences in the blood are well

marked and are said to be significant. In woman the blood contains a less number of red corpuscles—about four million five hundred thousand in a cubic millimetre to five million in man. It has a larger percentage of water and a lower specific gravity. As compared with man, therefore, woman is naturally somewhat anæmic. The pulse-beat is from eight to twelve per minute faster than in man.

Some interesting differences are now clearly made out between man and woman in respect to birth, death, and disease. Statistics show that about one hundred and five boys are born to every one hundred girls in Europe and America. The proportion in other countries and among uncivilized races is said to be nearly the same. The greater mortality of males, however, begins with birth and continues throughout childhood and adolescence and the greater proportion of adult years. If, therefore, a count be made of boys and girls or men and women at any age after the first year, the females are found to be in a considerable excess, and this notwithstanding the decimation of women by diseases incidental to the child-bearing stage of their lives. These results, formerly attributed to accidental causes, are now known to be due to the greater natural mortality of males, and this is found to be in harmony with another series of sexual differences, namely, the greater power of woman to resist nearly all diseases. Hospital statistics show that women are less liable to many forms of disease, such as rheumatism, hæmorrhages, cancer, and brain diseases; and that while they are more liable to others, such as diphtheria, phthisis, scarlet fever, and whooping-cough, even in these the percentage of fatal cases is so much less that the absolute number of deaths falls considerably below that of men. Sudden deaths from internal causes are much less frequent among women. They endure surgical operations better than men, and recover more easily from the effects of wounds. They also grow old less rapidly and live longer. Among centenarians there are twice as many women as men. Women retain longer the use of their legs and of their hands. Their hair becomes gray later, and they suffer less from senile irritability and from loss of sight, hearing, and memory. In brief, contrary to popular opinion, woman is more hardy than man, and possesses a larger reserve of vitality. In this connection the absence of physical abnormities in woman should be noted. A mass of evidence from anthropological studies in Italy and England shows that degeneration marks, monstrosities, and almost all kinds of variations from the normal type are much less common in woman than in man. Here, too, we may note that statistics of the diseases to which men, women, and children are severally most subject, show a somewhat marked similarity between the diseases of women and of children.

Among the peculiarities of the female skull the following are definitely determined by Rebentisch, Mantegazza, Schaffhausen, and others. The skull of woman is smaller, the base relatively contracted, and the crown larger. The forehead is more nearly perpendicular, making a sharper angle with the flatter crown. The glabella and ridges above the eyes are less prominent. The parietal protuberances are more developed, but the occipital protuberances and the mastoid processes under the ears are less so. The lower jaw is smaller and more rounded. Relatively to the size of the head the face is slightly smaller and lower, and there is a little more prognathism than in man.

The long-disputed questions about woman's brain are now approaching solution in a few leading points. In the first place, woman's brain is of less absolute weight than man's, the proportion among modern civilized races being about nine to ten. This fact in itself has little significance, as man is heavier and taller than woman. If we consider the weight of the brain relatively to the height of the body, it still appears that woman's brain is smaller; but if, as is more just, we consider the weight of the brain relatively to the weight of the body, it appears that there is nearly perfect equality, the difference, if any, being in favor of woman. These results are still of little value, for, as fairly pointed out by Havelock Ellis, other corrections must be made, such as this, that woman has relatively more fat and less muscle than man, the latter, of course, making greater demands upon the brain. On the whole it appears that there is no considerable difference, such as there is being in woman's favor. Of more significance in its bearing upon woman's mental capacity is the relative size of the different parts of the brain. Here it is shown that the lower centers as compared with the hemispheres are larger in the female brain. In the cerebrum itself the frontal region is not, as has been supposed, smaller in woman, but rather larger relatively. The same is true of the occipital lobe. But the parietal lobe is somewhat smaller. It is now believed, however, that a preponderance of the frontal region does not imply intellectual superiority, as was formerly supposed, but that the parietal region is really the more important. As a balance, perhaps, to these female deficiencies, we may note that the circulation of the blood seems to be somewhat greater in woman's brain. In respect to her whole physical structure woman is less modified than man and shows less tendency to variation. Women are more alike than men.

Before proceeding to consider the purely mental peculiarities of woman, we may pause for a moment to ask whether the facts already cited have any bearing upon the various theories regarding woman's nature that were mentioned above. Concerning the

superiority of either sex—at any rate a rather meaningless question—little or nothing appears. Woman's greater vitality and immunity from disease might be offered to balance her thinness of blood and preponderance of lower brain centers. Concerning the hypothesis of the infantile character of woman, however, the above summary is more significant. We see at once that a large proportion of her physical peculiarities are also infantile traits. The rounded form, the larger proportion of fat, the percentage of water in the muscles, the greater length of the trunk as compared with the arms and legs, the forward inclination of the head and of the upper part of the body, the deficiency of red corpuscles in the blood, the rapid pulse-beat, the character of the voice and position of the larynx, the large size of the thyroid gland, the contraction of the base as compared with the crown of the skull, the perpendicular forehead, the less prominent glabella and eyebrows, the smaller mastoid processes and the large parietal protuberances, the small, rounded lower jaw, the smaller, lower, and more prognathous face, the preponderance of the lower brain centers and the greater relative weight of the whole brain (if the latter be admitted), all these are distinctively infantile marks.

Let us now trace well-marked psychical differences between man and woman. It should not be necessary to state here that in all these studies average women are compared with average men, but not a little confusion has resulted oftentimes from comparing the best women with average men, or the best men with average women. First, as regards the senses, the popular opinion that woman's sensibility is finer than man's does not seem to be verified by experiment. Lombroso, collecting the results of Italian and English investigators, believes that woman's sensibility is somewhat more obtuse in touch, taste, sight, and hearing, and that her sensitiveness to pain is decidedly less than man's. But each of these conclusions is open to question. Careful experiments made by Drs. Bailey and Nichols in this country showed that the women had a finer sense of taste than the men, but that the men were superior in delicacy of smell. In sight and hearing no conclusive results have been obtained. Attention is called to the fact that piano tuners, and tea and wine tasters, are almost always men. In respect to all the senses more experiments are needed to test the comparative fineness of sensibility. Havelock Ellis, who sums up a large amount of evidence on this head, believes with Galton that women have, on the whole, somewhat less sensibility than men, and that it is their greater affectability or nervous irritability that has given rise to the popular notion of their finer sensibility. In respect to color blindness there is a remarkable difference between the sexes. About three and a half per cent of men are color-blind to a marked extent, while not more than

four tenths of one per cent of women are so. None of the popular explanations of this difference are at all adequate. The difference is a constitutional one between the sexes in this era, and is no doubt one of the forms of the greater variational tendency in man.

The general opinion that women are superior to men in manual dexterity seems to be borne out neither by actual experiment nor by accurate observation of woman's work in the mechanical arts. Experiments by Dr. Bryan on rapidity of movements with seven hundred and eighty-nine school children showed that the rate was slightly greater with boys at every age from five to sixteen years, except at the age of thirteen. The same experiments showed that rapidity increased regularly with age. Bryan also made experiments in precision of movements, with the result that there was little difference between the sexes, the figures showing a slightly greater precision for boys. Gilbert's painstaking and accurate experiments upon voluntary motor ability in twelve hundred school children in New Haven, including fifty girls and fifty boys for each year from six to seventeen, gave practically the same results. The tests were based upon the number of taps that could be made in five seconds with the finger. The boys excelled at every age without exception. The average number of taps in five seconds for boys was 29·4, for girls, 26·9; but the rate increased in both sexes from an average of about twenty-one at six years to thirty-four at seventeen years. Gilbert's experiments upon the reaction-time of school children showed that the reaction-time of boys was uniformly shorter at every age from five to seventeen, and that the time in both boys and girls decreased uniformly with age except a slight retardation at fourteen. In respect to dexterity in the manual arts there is much conflicting testimony. Havelock Ellis's inquiries concerning woman's skill in laboratories, in the cigar and cigarette trades, in cotton spinning and woolen weaving, etc., led him to the result that with few exceptions the finer and more dexterous work is done by man in fields where both sexes have equal opportunities and practice. In the cigar and cigarette trades of English manufacturing centers large numbers of women are employed, but are set to the coarser and lower grades of work, men being required to make the finer grades of cigars and to fold the narrow margins of the cigarette papers. Instructors in laboratories in coeducational institutions with few exceptions pronounce the men to be far more skillful in the use of the microscope and all other delicate instruments and to require less direction in the prosecution of their work. The superiority of women in needlework could not be adduced in this connection any more than the superiority of men in many fields where women have not entered into competition with them.

We come now to the well-worn theme of the purely mental differences between the sexes, and here I shall make a brief summary of the more important and well-recognized differences, citing experiments and statistics where they are possible. In perception, woman is in general decidedly quicker than man. She reads a paragraph or book more quickly, and, knowledge of the subject being equal, she grasps more of it. In perception of objects she grasps more quickly a number of wholes or groups, and has a rapid unreasoned perception of relations which has the appearance of intuition. Her perception of details, however, is less accurate than man's, and her rapid reference of things to their proper classes extends only to matters of common human experience. In apperception the subjective factor is larger in woman, and she sees things more from the standpoint of her own experience, wishes, and prejudices. Even more than in man, where feeling is strong, objective perception is blind. Hence women make poorer critics than men, and more rarely are they impartial judges. For the formation of concepts, especially the more abstract ones, woman's mind is less adapted than man's. She thinks more in terms of the concrete and individual. Hence number forms and the associations of colors with sounds are, as is found, more common among women. Differences in habits of thought between the sexes may be well illustrated by a simple experiment in association. If fifty men and fifty women be required to write as rapidly as possible one hundred words without time for thought, in the women's lists more than in the men's will be found words relating to the concrete rather than the abstract, the whole rather than the part, the particular rather than the general, and associations in space rather than in time. As Lotze keenly remarks, women excel in arranging things in the order of space, men in the order of time. Men try to bring things under a general rule, without so much regard to the fitness or symmetry of the result. Women care less for general rules, and are inclined to look only to the immediate end in view, aiming to make each thing complete in itself and harmonious with its surroundings.

In respect to memory, as far as any general statements can be made, woman is superior. In memory tests college girls surpass boys. In Gilbert's tests on New Haven school children, however, the boys were superior in the exact reproduction of an interval of time. In reasoning of the quick associative kind women are more apt than men, but in slow logical reasoning, whether deductive or inductive, they are markedly deficient. They lack logical feeling, and are less disturbed by inconsistency. Analysis is relatively distasteful to them, and they less readily comprehend the relation of the part to the whole. They are thus less adapted to the plodding, analytical work of science, discovery, or invention. Their in-

terest lies rather with the finished product. Of the 483,517 patents issued by the U. S. Patent Office prior to October, 1892, 3,458 were granted to women. In general, woman's thought is less methodical and less deep. The arts, sciences, and philosophy owe their progress more to man than to woman. Whether one studies the history of logic, mathematics, or philosophic thought, of the special sciences or scientific discovery and invention, of poetry or general literature, of musical composition or technique, of painting, sculpture, or architecture, one is engaged more with the names of men than of women. Even in those spheres for which woman by her peculiar physical or mental qualities is particularly adapted, such as vocal music, the stage, and the writing of novels, it is doubtful whether a list of the greatest artists would include more women than men. Even in the arts of cooking and dressmaking, when men undertake them they often excel. Woman, owing to her greater patience, her intuition, and her retentive memory, as well as her constant association with the young, is especially qualified for teaching and has equal or greater success in this work than man. Yet all educational reforms, from the kindergarten to the university, have originated with the latter.

What woman loses in profundity she gains in quickness. She excels in tact, and extricates herself from a difficulty with astonishing adroitness. In language she is more apt than man. Girls learn to speak earlier than boys, and old women are more talkative than old men. Among the uneducated the wife can express herself more intelligently than the husband. Experience in coeducational institutions shows that women are more faithful and punctilious than men, and at least equally apt. In colleges where a record of standing is kept the women gain probably a somewhat higher average. In the years immediately following graduation the men make much greater intellectual progress. Women reach their mental maturity at an earlier age, and develop relatively less after maturity. In many kinds of routine work, especially that requiring patience, women are superior, but they are less able to endure protracted overwork.

We have seen that woman is less modified physically than man and varies less from the average. The same is true mentally. Women are more alike than men and more normal, as it were. The geniuses have been men for the most part, and so have the cranks. Woman's thought pursues old rather than new lines. Her tendency is toward reproduction, while man's is toward production. Woman loves the old, the tried, and the customary. She is conservative, and acts as society's balance-wheel. Man represents variation. He reforms, explores, thinks out a new way.

One of the most marked differences between man and woman is the greater excitability of the nerve centers in the latter. Woman

possesses in a higher degree than man the fundamental property of all nervous tissue, irritability, or response to any stimulus. The vasomotor system is particularly excitable, and this fact is in immediate connection with her emotional life. That woman is more emotional than man is only another way of stating the same fact. Various expressions and bodily changes which are really the ground of emotions, such, for instance, as laughing, crying, blushing, quickening of the heart-beat, are more common in woman, and in general her face is more mobile and witnesses more to her mental states. Various forms of abnormal mental conditions, closely connected with the emotions, such as hysteria, are more frequent among women. Women are more easily influenced by suggestion than men, and a larger percentage of them may be hypnotized. Trance mediums are usually women. The word witch has been narrowed almost wholly to the female, and this may be explained by the fact that various forms of mental disturbance connected with superstitious notions are more frequently manifested in women. Sympathy, pity, and charity are stronger in woman, and she is more prominent in works that spring from these sentiments, such as philanthropy and humane and charitable movements. Woman is more generous than man. Her maternal instincts lead her to lend her sympathy to the weak and helpless. She cares for the sick and protects the friendless, and, seeing present rather than remote consequences, she feeds the pauper and pardons the criminal.

In morals a few distinctions between the sexes are well determined. Male criminals outnumber female criminals about six to one. Woman's sympathy and love, her physical weakness and timid nature, her domestic and quiet habits, ill adapt her to the criminal life. Morally bad women too usually find other more attractive fields open to them. Some forms of crime, indeed, such as murder by poisoning, domestic theft, and infanticide, are much more common among women. When women do become criminals their crimes are often marked by greater heinousness, cruelty, and depravity. It is said by Lombroso and his school that in respect to cruelty in general woman surpasses man, particularly in her conduct to her own sex. Woman's appetites are not so strong and her passions are less intense. She is freer from intemperance and related forms of vice. The most marked moral superiority of woman appears in her altruism; her greatest moral defect in her untruthfulness. In her altruistic life of love and self-sacrifice woman shows herself the leader in the supreme virtue of Christian civilization. As far as she leads in this, so far does she fall behind in veracity. She has not the same conception of abstract truth as man, but thinks more of the good to be attained. Deception and ruse in woman, far more than in man, have become a habit of

thought and speech. A series of conditions, social, intellectual, and physiological, have forced this habit upon her as a means of self-defense.

Woman's religious nature is stronger than man's. She possesses in a marked degree the qualities of reverence, dependence, devotion, trust, and fidelity. Fear and timidity are feminine qualities, while faith is so natural to woman that she is disposed to credulity rather than to skepticism.

Let us pause a second time to see what theory, if any, our results establish. Here, again, from her mental differences the doctrine of woman's inferiority receives no support—inferior, no doubt, in philosophy, science, and invention, and in her conception of abstract truth and justice, but superior in intuition, in charity, in temperance, in fidelity, in balance. But here again, as in her physical peculiarities, woman approaches the child type. This is seen in the preponderance of the emotional life over the discriminative, and of the impulsive over the voluntary. So also the quick perception and the retentive memory remind us of the child more than do the stern logical processes of the man. Woman's mental associations, selecting the concrete, the individual, the whole rather than the part, relations in space rather than in time, are also those of the child. Woman's receptivity, her faith and trust, her naïve freedom from skepticism, her fear and timidity, her feeling of dependence, her religious instincts, are all child traits. Children, like women, have slower reaction-time and lesser motor ability, are more easily hypnotized, have more number forms and color associations, have less power of inhibition, express their emotions more in their faces, and more readily give way to tears and smiles. Modern child study has shown that children are more cruel than adults and have little power to discriminate between truth and falsehood. They also are sympathetic and changeable, and act with reference to present rather than remote ends. Woman in respect to her altruism, pity, and charity has less resemblance to the child, but these traits are so intimately connected with her duties of motherhood as to have little bearing upon the theory of her naturally infantile constitution.

The hypothesis that woman approximates to the primitive rather than to the child type, that she represents arrested development, may be said to receive a certain amount of confirmation from her mental traits. Indifference to physical and psychical pain, freedom from color blindness, the preponderance of memory and intuition over reason, lack of mechanical inventiveness, conservatism and adherence to custom, precocity, changeableness, cruelty, tact, deceitfulness, emotional expression, religious feeling, are all traits conspicuous among primitive races, and, as we have

seen, are more noticeable in women than in men. That women are less modified mentally and are more alike than men also argues for arrested development. It is well known that in insane asylums the female patients are more destructive, noisy, abusive, and vicious than the male patients, although their insanity is less serious and more curable. This fact, together with the other, that when women become bad they become more hopelessly bad, has led some too hastily to conclude that women, like children, are natural savages. The fact that woman has less logical and philosophical ability and has taken so little part in the development of the sciences, arts, and inventions, which are considered to represent human progress, is adduced as further confirmation of this theory. But in many of her mental traits woman departs further than man from the savage type. In her moral qualities she represents higher evolution. This is notably true in respect to her altruism, charity, sympathy, and pity. Woman's greater humanity, philanthropy, conscientiousness, fidelity, self-sacrifice, modesty, and patience, as well as her lesser disposition to crime, are qualities which separate her further than man from the savage. The same may be said of certain other subtle and scarcely definable feminine qualities, such, for instance, as grace and refinement. Woman's development along these lines certainly has not been arrested, and although it may be argued that these qualities are the logical outcome partly of her physical weakness and partly of her maternal duties, still it would be difficult to show that evolution in this direction represents less progress than in the more intellectual direction in which man has developed. It must be admitted, however, that woman's purely intellectual development has been retarded, and this may have a practical significance considering that on these qualities the struggle for existence now so largely turns.

But we must now consider another series of differences between the sexes which, it is alleged, more fully prove the arrested development of woman. These relate to methods of dress and adornment and to habits of life and conduct, in which the history of civilization has shown a constant and definite advance, but in which, it is said, woman is centuries behind. While some of these differences appear of a trifling character, we must admit that they have a certain cumulative force, and even the most trifling may have an anthropological significance.

One of the most interesting chapters in anthropology is that relating to dress. The origin of dress, as is now well known, was the desire to adorn the person, not to protect it. For the sake of adornment, the savage was willing not only to expend a considerable amount of time and wealth, but even to undergo much physical discomfort. To this end were used various paints and

pigments, preferably of the brighter colors, feathers of brilliant hues, spotted or glossy skins and furs of animals, beads, shells, shining or colored stones and bits of metal, together with various oils, ointments, and perfumes, all designed to please the sense of sight or of smell. To the same end various mutilations of the body were endured, such as tattooing, or piercing the lips, nose, cheeks, or ears for the insertion of rings or pieces of fancy stone or metal. The neck, also, ankles, wrists, and fingers were used as convenient places for the attachment of ornaments, such as rings of gold or strings of shell or precious stones. The hair, too, was left uncut and tied up in various fantastic ways, and decorated with shells, beads, and gold and silver ornaments. Almost equally early, however, dress was made to serve another purpose than that of pleasing the senses of the beholder. It was used as a means of gaining favor and power by serving as a symbol of the wealth of the wearer. Hence those feathers, skins, and furs which were most rare and difficult to obtain were preferred, and those metals and stones which were not only brilliant but costly, such as gold, silver, diamonds, and rubies. In the manner of wearing this ornamental dress, neither protection nor concealment of the person was so much considered as display. The loose and flowing garments often impeded the movements of the wearer, so that in hours of work or warfare they must often be left behind. In inclement weather, also, they were often laid away, as it was considered more important to protect the dress itself than the person. Starting with these primitive ideas, the evolution of dress has shown a steady progress from display to utility. Clothing tends to be substituted for dress and to have for its end the protection and comfort of the body. Paint, feathers, and pieces of stone and metal tend to disappear as useless. The gaudy colors of the savage, the purple of chiefs and kings, the white of the Romans, give place to the plainer and more useful grays and blacks. Tattooing and other mutilations disappear, skins and furs are replaced by the more comfortable woven cloths, the flowing and dragging robes give way to the close-fitting garment which impedes the movements as little as possible, and the hair is cut shorter for convenience and economy of time. Together with these changes we notice that the symbolic character of dress disappears, so that less and less is it possible to judge of a person's wealth by his attire. It should be observed that none of these ends toward which the evolution of dress is tending have been fully realized even in the most civilized societies, but the civilization of any people is largely judged by the extent to which these ends have been realized.

In the light of these principles the theory of woman's arrested or retarded development receives, it is said, much confirmation.

Among the women of the most civilized communities the idea of dress has only partly given place to that of clothing. The flowing and, upon occasions, even the trailing robe still persists. The hair is uncut and fantastically arranged with bits of shell or metal, and sometimes decorated with ornaments of shell, silver, or gold, or imitations of these. Feathers are still worn upon the headdress, and the headdress itself is purely for adornment, affording little or no protection to the head, and in inclement weather is sometimes left behind for safety or exchanged for a simpler kind. Upon the streets of European towns peasant women in the morning are usually seen with uncovered heads, and in America neighborly women are often so seen passing from house to house, but never upon state occasions. Furs are still worn by both sexes in winter, but much more commonly by women. The use of striking colors, such as red, yellow, blue, green, and purple, is still frequent in the dress of women and children, but much less so in men's dress, where the blacks, grays, and browns prevail. Survivals of the primitive custom of leaving parts of the body entirely exposed and unprotected are still seen in woman's evening dress, showing how little the idea of display has given place to that of utility. The use of rare metals and stones as ornaments for the ankles, wrists, fingers, ears, nose, lips, and neck persisted in the dress of women long after it became extinct with men. Rings in the ears were commonly worn by women within the memory of many of us, and rings and stones upon the wrists and fingers are still very common. For these purposes brilliant stones, such as diamonds, are much prized, but are not worn to the same extent by men as by women. Survivals of the neck ornaments are still seen in the various forms of pins and necklaces. Beads, so highly prized by the lower races, still persist to some extent in the bead trimming of woman's dress. The use of paint to decorate the person is now practically extinct with both sexes, but, as a means of decorating the face, was practiced by women within comparatively recent times. In respect to various powders and perfumes the evolution has not been so rapid, and they are still in use among women to some extent. Mutilations of the body for ornamental purposes are all but extinct, but among women certain mutilations, such as piercing the ears, unnatural constriction of the waist, and pinching of the feet, have persisted almost to the present time. In countries like China, where the last of these is still practiced, the practice is confined to women. In certain other trifling matters there is in woman's dress a suggestive survival of primitive customs. The dress of the primitive man was loosely and irregularly attached to the body, and was fastened with strings or thongs or afterward with pins of metal. Later these pins were attached to the

garment and bent into the form of hooks. Buckles, and finally buttons, took the place of the primitive pins and hooks. But women still use the metal pins, and the primitive lack of definite correspondence between the dress and the body is seen, for instance, in the hat or bonnet, which does not fit the head and must be fastened on with strings or pins. This retarded development and absence of differentiation in woman's dress is curiously illustrated in the case of shoes. Only a few decades ago girls' and women's shoes were made straight and worn indiscriminately on either foot, while men's shoes were uniformly made rights and lefts. In many country stores old women's shoes may still be found made straight, while women's overshoes and rubbers are commonly so made at present, and are worn on either foot.

But the most striking case of retarded development in woman's dress is seen in the persistence of the idea that dress is not so much a protection for the body as a symbol of the wealth of the wearer or the wearer's family. In the more civilized societies now it is no longer possible to judge of a man's wealth by his attire; but to the same extent this can not be said of his wife and daughters. In the case of the latter the two primitive purposes of dress—ornamentation and expenditure—are still ascendant. We see the same display of rare and costly furs and feathers, of gold and diamonds, of velvets, laces, and silks, and of harmony of colors, and a somewhat constant relation between the cost of such display and the wealth of the owner. In her emancipation from the tyranny of fashion in dress woman has made less progress than man. In slave-like obedience thereto she submits to frequent and expensive changes in style, to heavy and cumbersome garments involving the sacrifice of comfort, health, and economy.

In justice to the above principles it is only fair to state that it is not urged by those who bring them forward that the dress of man is perfect or free from savage elements, or that the æsthetic motive common to the dress of the primitive man and of civilized woman is not a worthy one, but only that in the evolution of dress there is a definite progressive movement from the primitive conception of display and expenditure to the modern conception of utility and comfort, and that in this movement woman's dress has been retarded or arrested at a primitive stage.

Certain other facts than those of dress point, it is said, to woman's arrested development. The division of labor which marks the progress of civilization has reached no such extent in the work of woman as in that of man. In fact, it may be said that there is in woman's work hardly any division of labor, except in so far as, in recent years, she has entered upon pursuits formerly followed only by men. As we have seen that women

are more alike physically and mentally than men, so their work is more alike. In domestic life, which still includes the mass of representative women, each one either does her own housework, or has it done by female servants whose labor is equally unspecialized. No man now in civilized communities makes his own clothes, yet this is not uncommon among women, and in primitive communities they may even spin and weave the material. Not only is their work and manner of work more primitive, but also their tools. In the German cities on market day, for instance, may be seen numbers of men and women bringing their produce from the country, the men using carts or wagons propelled by themselves or their horses, but the women bearing their burdens in baskets upon their backs in quite the primitive fashion.

Before attempting any summary of our results I must call attention to some recent biological researches which may throw new light on the natural relation of the sexes. It has been shown by Geddes and Thomson, Fouillée and others, that in many of the lower and simpler orders of animals the female is larger than the male. This is true, with exceptions, throughout the animal world as high as the amphibians, and is in close logical connection with certain other important differences between the sexes. These, observed also best among the lower orders, are as follows: The male is active, restless, agile. The female is passive and quiescent. She has lower temperature, greater longevity, and a larger fund of vitality; her birth is the accompaniment of conditions of better nourishment. The male is katabolic, representing the expenditure of energy, individualism, variation, and progress. The female is anabolic, representing economy and the building up, conserving, and reproductive functions. She is nearer to and more representative of the race. These, it is said, are natural sexual differences seen at the very threshold of life in the contrast between the male and female cells, and so far as these same differences appear in man and woman they can not and need not be accounted for by any theories of natural or sexual selection nor by artificial social conditions. Those peculiarities of modern woman which are contrary to the natural constitution of the female, such as her smaller size and her alleged retarded development, are rather the qualities in need of explanation. It has been suggested that the greater size and strength of the male among the higher vertebrates may be explained as the indirect result, in part, of his combats with rivals, and, in part, of his greater activity in protecting and supporting himself and his mate when the maternal duties of the latter incapacitate her for these actions, and furthermore that the retarded development of woman is due to artificial and unnatural restrictions arising

from a sort of bondage which the above conditions have made possible. Again, if it should be shown that woman conspicuously resembles the infant in body and mind, very unwarranted inferences might be drawn from this. It is true that the infant of the human species has certain curious points of resemblance to the lower animals, notably the ape, but it is equally true that the infant ape has certain marked resemblances to the human species which the adult ape does not have. By analogy we may infer that the human infant has closer resemblance to the more highly developed being of the future than the human adult has, and if woman is more like the child than man is, then she is more representative of the future being. The matter, in fact, reduces itself probably to this: that woman, like the child, represents the race type, while man represents those variable qualities by which mankind adapts itself to its surroundings. Every woman is, as it were, a composite picture of the race, never much worse nor much better than all. Man is, as it were, Nature's experiment, modified to reflect, if possible, the varying conditions of his environment. If superiority consists in adaptation to present environment, then man is superior; if it consists in the possession of those underlying qualities which are essential to the race—past, present, and future—then woman is superior.

The facts examined in this article, then, lend a certain amount of confirmation to all of the four theories mentioned at the beginning, except so far as woman's inferiority may have been implied in them. Woman's more intimate connection with the life history of the race, her childlike, representative, and typical nature, her embodiment of the everlasting essentials of humanity, her at present arrested or retarded development—all these are indicated by modern anthropological studies. These results are indicated, not proved. They must be verified, supplemented, and no doubt, in some instances, corrected by future studies along these lines.

From these studies there would be no want of lessons for political and social reformers, if they would learn them. From woman's rich endowment with all that is essentially human, the most devoted enthusiast for woman's rights and equality might gain new inspiration. From her retarded development the educational and political reformer might learn that woman's cause may suffer irretrievable damage if she is plunged too suddenly into duties demanding the same strain and nervous expenditure that is safely borne by man, and if it is attempted to correct in a century the evil of ages. From woman's childlike nature the thoughtful "spectator of all time and all existence" might learn yet a deeper and more significant lesson. May it not be that woman, representative of the past and future of humanity, whose quali-

ties are concentration, passivity, calmness, and reserve of force, and upon whom, more than upon man, rest the burdens and responsibilities of the generations, is too sacred to be jostled roughly in the struggle for existence, and that she deserves from man a reverent exemption from some of the duties for which his restless and active nature adapts him?

IRRITABILITY AND MOVEMENT IN PLANTS.*

By D. T. MACDOUGAL.

WITH the extension of information concerning the scope, purposes, and adaptations of the movements exhibited by plants, the determination of the nature of the specific forms of irritability under which these movements are induced becomes a question of very great interest. The more apparent movements of plants have long been matters of common observation, yet no apprehension as to their real nature existed before the middle of the present century. Previous to that time natural philosophy was chiefly busied in the definition of the "distinctive qualities" of the great groups—plants, animals, and minerals—and perpetuated without serious inquiry the beautiful vagaries of Aristotle as to the possession of a materialistic soul by plants. Both before and after the dictum of Linnæus, "Lapides crescunt, vegetabilia crescunt et vivunt, animalia crescunt, vivunt et sentient" (1735), the literature of natural history is rich in allusions to the possessions of functions by plants corresponding to the senses of animals. The only actual distinction made by Linnæus between the two groups was the denial of ideal perception to plants. Erasmus Darwin, in his Zoönomia (1794), supposes that plants possess voluntary power. He says: "The sleep of animals consists in the suspension of voluntary motion, and as vegetables are subject to sleep there is reason to conclude that the various actions of opening and closing their petals and foliage may be ascribed to a voluntary power; for without the faculty of volition sleep would not have been necessary for them." Probably a fair representation of prevalent thought on this subject at an early part of the present century is made by the admirable treatise of Tupper,† in which he attributes to plants irritability, a form of instinct (to account for

* Abstract of two lectures given before The Fortnightly Scientific Club of the University of Minnesota, October 20, 1894, and January 19, 1895.

† An Essay on the Probability of Sensation in Vegetables, with Additional Observations on Instinct, Sensation, Irritability, etc. London, 1811. By James Perchard Tupper, Member of the Royal College of Surgeons and Fellow of the Linnæan Society.

spontaneous movements), and a low form of sensation, which he supposes might be accompanied by a degree of consciousness—"and as sensation does exist in animals independently of those eminent attributes with which it is combined in our natures as rational agents, may we not reasonably infer that vegetables have likewise their share of sensitive power, and consequently the means of enjoying their existence?" Hence, as vegetables are necessarily so different from animals in their mode of existence, it is very evident that we can not form any idea how they feel under any circumstances; but we are not on this account to conclude that they are destitute of every kind of sensation. "As they possess *life*, *irritability*, and *motion*, spontaneously directing their organs to what is natural and beneficial to them, and flourishing according to their success in satisfying their wants, may not the exercise of their vital functions be attended with some degree of sensation, however low, and some consequent share of happiness? (*Vide* Smith's Introduction to Botany.)"

Biological literature even in recent years abounds in expressions concerning phenomena of plant life corresponding to the sensorial action of animals. These conceptions were fostered to some degree by Charles Darwin's Power of Movement in Plants and other works, in which the actions of plants are described in terms strictly applicable to the sensorial reactions of animals only. Thus he says of the irritability of the tips of roots, "It is hardly an exaggeration to say that the tips of the roots affected and having the power of directing movement in the adjoining parts act like the brain of the lower animals." This phraseology was, no doubt, intended to be suggestive rather than definitive, but to it may be traced many current erroneous impressions. "Instinct," "intelligence," "nervous action," and a score of similar terms are used indiscriminately to designate actions of plants far removed in character from those denoted by the original meaning of such expressions. A partial justification of this misapplication of terms is found in the lack of systematically arranged information concerning the form of sensibility exhibited by plants. With an extensive nomenclature dealing with the great mass of detail of the neuro-muscular action of animals at command, the apparent similarity between the irritation reactions of plants and the sensorial reactions of animals has been held to be real, in a manner strongly suggestive of the anecdote of the German peasant who, seeing a moving locomotive for the first time, exclaimed, "There's a horse inside of it, or how could it run?"

The conception of the relative character of these two great groups of reactions may be attained by outlining the conditions which have led to the development of each rather than by an accentuation of external similarities.

Protoplasm, the physical basis of animal and plant life, has among other characteristics that of irritability to several classes of stimuli furnished by its environment. It reacts to these stimuli by adjustments, many of which are accomplished by motion or contraction, and to others by metabolic changes. What agencies have been potent in the development of this primal irritability of protoplasm, through reflex action, into sensorial reaction in the animal, and into the various forms of specific irritability in the plant?

It is unquestionable that the paramount necessity for every organism is that of self-preservation. To obtain food, avoid injury, and secure the proper degree of the environmental conditions of light, temperature, and moisture, are then to be considered as the fundamental necessities of every organism.* Animals are organisms in which destructive metabolism prevails, in which more energy derived from complex foods is dissipated than is conserved. Connected with and underlying this condition of the metabolic balance is the fact that animals have steadily developed toward motile forms. In the accomplishment of the conditions of life, motion has become to them an indispensable function. The necessity for the ability to direct the locomotory movements in the avoidance of danger and the attainment of food and comfort has led to the development of irritability into the forms of sensorial action. Plants, on the other hand, are organisms in which constructive metabolism prevails, in which more energy is conserved than is consumed in the performance of the necessary work. Underlying this state of the metabolic balance is the fact that plants have steadily moved along a line toward fixed forms. Consequently irritability has been developed into forms which would be of service to the plant in securing food and protection without moving from place to place. Not only has the protoplasm of the plant developed an irritability to different qualities of the stimuli to which animal protoplasm responds, but it also reacts to certain forces to which the animal is inert, by a mechanism different in every essential from that of the animal. These two lines of development of the primal irritability of protoplasm by reason of the metabolic activity and other conditions attendant on each are so widely divergent that great care must be exercised in the comparison of the higher forms of sensibility exhibited by the plant and the animal. In the animal the higher form is that of sensorial reaction with its vast range of usefulness. In the plant this power has developed with equal facility for the necessities of the organism, but even in its highest form it must needs be

* Arthur, Special Senses of Plants. Proceedings of the Indiana Academy of Sciences, 1893.

termed irritability, although it has attained a degree of specialization in which its delicacy and usefulness are equal to those of sensorial action, and may surpass them in some instances.

Among the more marked forms of irritability shown by the plant may be mentioned those by which it reacts to gravity, radiant energy (heat, light, and electricity), shock, and metabolic action. A clear conception of the character of the reactions of plants to these stimuli may be attained by a consideration of those shown toward gravity, light, and contact of solid bodies.

Since the plant is a fixed organism and can not move in search of food, it is essential that its roots thoroughly penetrate the soil of the locality in which it is found, in such manner as to place its absorbing surfaces (root hairs) in contact with whatever nutrient solutions the substratum may contain. The necessity for such penetration of the soil has led to the development of irritability to gravity in the protoplasm of the roots. Primary roots in response to the stimulus of gravity tend to place themselves in a position with their axes lying parallel to the force of gravity and the tips pointing vertically downward. But if all the roots assumed this position they would depend from the stem in a compact mass in a manner not advantageous to the plant. The secondary or smaller roots, however, react to gravity in such manner that they place their axes at right angles to the line of force, thus securing a penetration of the soil in a second direction. These forms of reaction to gravity are also exhibited by other organs of the plant but do not occur to any extent among animals. The manner in which a primary root curves to place its axis in a vertical position may be seen in Fig. 1, and that of a culm of grass to become erect in Fig. 2.

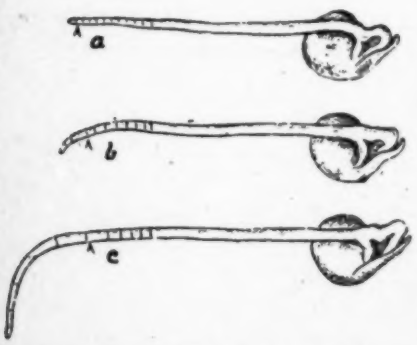

FIG. 1.—DOWNWARD CURVATURE OF A PRIMARY ROOT OF PISUM WHICH HAS BEEN PLACED IN A HORIZONTAL POSITION.

An important requirement of aërial organs is that they assume a position in which their surfaces will be exposed to the sunlight at an angle most advantageous for the performance of their functions of the formation of food and transpiration. To meet this need, those portions exposed to the light have acquired a specific manner of response to the light by which some place their surfaces parallel and others at right angles to the direction of the rays. Gravity acts continually and invariably in one direction, and with a constant force. Consequently the movements of

plants in response to this stimulus are comparatively simple. Light has its source in the sun, which varies its position through one hundred and eighty degrees during the daytime and is wholly

FIG. 2.—UPWARD CURVATURE OF A CULM OF GRASS WHICH HAS BEEN PLACED IN A HORIZONTAL POSITION. The dotted outline denotes the original position of the plant.

absent at night. In consequence the movements of the plant to adjust its surface to this stimulus of ever-varying direction and intensity are of great complexity. This variability of the stimulus has, moreover, induced in the plant a delicacy of irritability toward light far beyond that exhibited toward gravity. The manner in which leaves react to light may be seen in Fig. 3.

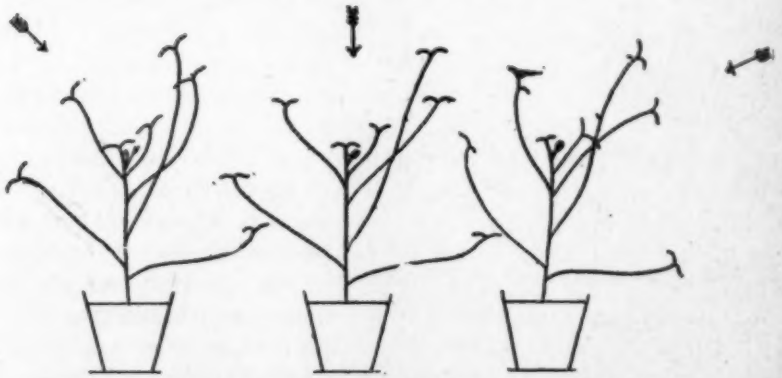

FIG. 3.—DIAGRAM OF LIGHT POSITION OF LEAVES. The arrows indicate the direction of the rays which have fallen on each plant separately.

In a large and varied category of plants it has become of great importance that they execute certain movements when solid bodies come in contact with them or strike their surfaces. This irrita-

bility to contact or impact has been developed in a number of carnivorous plants, which entrap and hold insects which serve as food; in the tendrils of climbing plants, which coil around supports and lift the foliage and flowers into sunlight; in a large class of "sensitive plants," which quickly fold their leaves on the reception of such a stimulus, thus avoiding injury from hail or grazing animals. The need of delicacy is much greater here than

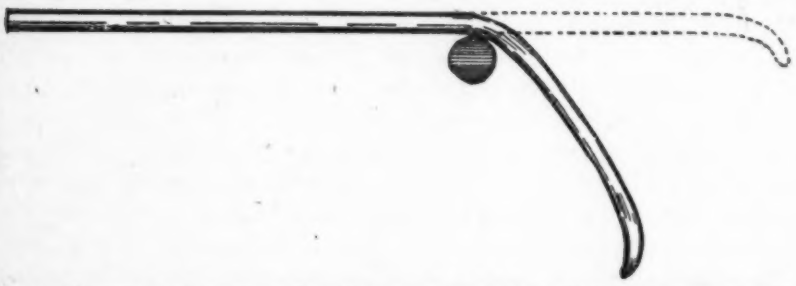

FIG. 4.—TENDRIL OF PASSIFLORA FORTY SECONDS AFTER CONTACT OF WOODEN ROD AGAINST LOWER SURFACE. The dotted outline designates the original position of the organ.

in the previous forms described, and the response is much more marked and rapid. As an example of this form of irritability may be cited the contact reaction of tendrils. In Fig. 4 is shown the curvature of a tendril forty seconds after it has been lightly touched with a wooden rod.

With the general features of these reactions at hand, the question as to the mechanism by which they are accomplished becomes one of very great interest. The first point which naturally presents itself is the reception of the stimulus by the plant. Is every cell in the plant or organ affected by the stimulus, and do all bear an equal and similar part in the resulting movement? It is found by experiment that if the terminal region (see Fig. 1) of a root is cut away with a sharp razor, the root will no longer respond to gravity, but will remain in whatever position it may be placed. After a time, when the tip has been rehabilitated, the root regains its power of response to this force as before. The results of this and other experiments tend to show that the only part of the root which can receive the stimulus of gravity is a small mass of cells in the center of the tip. It may be seen, further, on reference to Fig. 1, that the curvature occurs in the fourth and fifth divisions from the tip. Here, then, is an instance in which a distinct mass of cells—"the perceptive zone"—receives the stimulus, and curvature results from the action of another mass of cells—"the motor zone"—several millimetres distant. This would, of course, imply that the impulse from the stimulus received by the perceptive zone was transmitted to the motor zone, and that the reception of the stimulus, the transmission of the im-

pulse, and motion were each accomplished by separate groups of cells. The receiving, transmitting, and motor zones are not always so distinctly separated, however. In stems, leaves, and other aërial organs the perceptive zone may extend over the greater part of the surface, including the region of curvature. In tendrils the perceptive zone comprises the superficial layers of tissue of the concave side of the organ throughout the region of curvature. It is quite probable in all these instances, however, that the cells receiving the stimulus are not identical with those causing the curvature, or, disregarding the cell, separate masses of protoplasm are differentiated for the performance of each of these functions. A clear conception of this mechanism may be attained by a consideration of the structure and action of a tendril. A tendril is generally of bilateral organization, consisting of a middle layer of pith between two layers of elastic and flexible mechanical tissue (wood); outside the wood, on both the upper and lower sides of the organ, layers of mobile thin-walled parenchyma cells, which in the active condition of the tendril are in a state of high internal tension; covering the parenchyma, a layer of epidermal tissue composed of elastic, thick-walled, but easily extensible cells (see Fig. 5). If a solid body is brought into contact with the concave

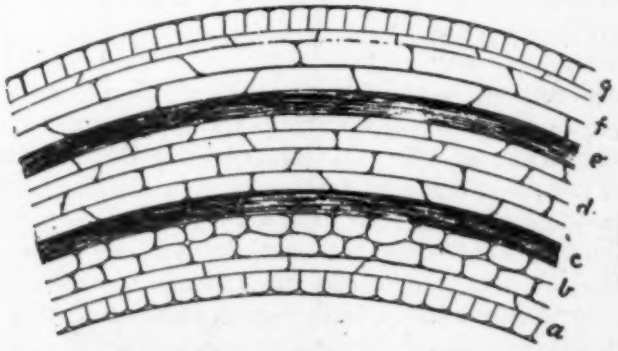

FIG. 5.—DIAGRAM OF THE LONGITUDINAL SECTION OF A TENDRIL IN THE REGION OF CURVATURE. *a*, epidermis (perceptive zone); *b*, parenchyma cells which before curvature were similar to *f* in form; *c*, *e*, wood; *d*, pith; *f*, parenchyma slightly more elongated than before curvature; *g*, epidermis of convex side.

side of a tendril, the pressure acts as a stimulus on the ectoplasm—the thin layer of protoplasm lining the walls—of the epidermal cells. The ectoplasm of these cells is connected with that of the thin-walled parenchyma cells at numerous points by means of very fine strands of protoplasm extending through the walls of the intervening cells. An impulse is conducted along the strands to the protoplasm of the thin-walled cells, and their action results in the curvature of the organ. The structure and action of the tendril are generally similar to those of a large number of stems.

The manner of action of the motor cells (Fig. 5, *c*, *e*) has not been clearly made out. By different investigators the curvature has been successively attributed to an accelerated growth of the convex (upper) side of the tendril, a retarded growth of the concave (lower) side, an increased turgor in the region of curvature with an increased extensibility of the walls of the convex side, and an increased turgor of the convex side only, coupled with an increased extensibility of the walls of the cells on this side. But recently the hypothesis that the curvature is due to the increased turgor of the concave side, with an increased extensibility of the walls of this side in one direction only, has been offered. Whether the last offers the true solution of the problem or not remains to be proved. However, it accounts for certain features of the curvature irreconcilable with previous explanations. The conditions of the motor cells after curvature may be seen in Fig. 5.

In plants provided with cushions of tissue—*pulvini*—for the purpose of rapidly displacing leaf stalks and other organs, the movement is effected by a direct contraction of the cells on the side toward which the organ is curved. It will be quite remarkable if it should be found that the rapid movements of the "sensitive plants" are effected by the contraction of the motor cells, and the slower movements of tendrils and other organs by the expansion of these cells.

Of the ultimate molecular changes ensuing in the cells of the motor or perceptive zones, as well as in the transmitting tissues, nothing is known, except that in such cells the metabolic action is necessarily very rapid. In this the physiologist confronts a problem which may not reach its final solution until the ultimate organization of protoplasm is at least approximately ascertained.

The delicacy of the mechanism of irritability in certain instances is such that the amount and intensity of the stimulus necessary to secure a reaction are extremely small. It has been found that tendrils would respond to the contact of a weight not greater than one five-thousandth of a milligramme, and that a plant in a dark chamber would curve toward the light afforded by a single spark from a small condenser coil, or to a light too diffuse to cast a shadow perceptible to the human eye. Some of the lower free-swimming forms have been found susceptible to the presence of an amount of oxygen so small as the one-trillionth part of a gramme, which is very nearly the atomic limit of this substance. This delicacy of perception is doubtless beyond that of the senses of the higher animals.

At all times the amount of a stimulus necessary to produce a response increases with the amount previously acting upon the plant. Thus a plant in total darkness will react to an extremely small amount of light, as has been pointed out; but, if placed in

a strong diffuse light coming from all directions, it will be found unresponsive to an increase of the light from one side far in excess of the amount just described. Pfeffer found that, while the spore tubes of ferns were ordinarily affected by an extremely small amount of sodium malate, yet, when placed in a one-hundredth-per-cent solution of this substance, would not respond to an additional amount of the substance until it reached a concentration thirty times as great. The results obtained by other investigators indicate that Weber's law is applicable also to the reactions of plants to light, and perhaps all forms of stimuli.

When a stimulus impinges upon a perceptive zone, the reaction shown by the motor zone does not occur simultaneously with the reception of the stimulus, but after a "latent period" of varying duration.

In Fig. 6 are graphically represented the features of the movement of a tendril which has been stimulated by the contact of a solid body (see Fig. 4). Thirty seconds elapsed after the stimulus was applied before the movement began. The contraction

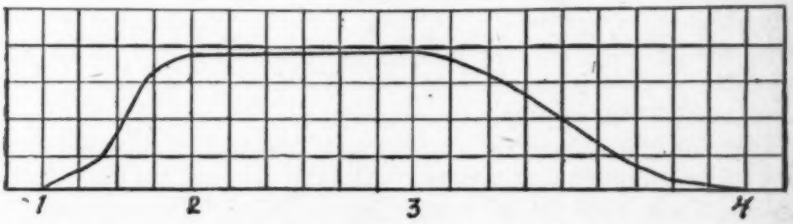

FIG. 6.—CURVE OF CONTRACTION OF TENDRIL. The distance of the curve from the base represents the amount of displacement of the tip; five centimetres on the base line represents five minutes; 1 to 2, latent period and period of contraction; 2 to 3, period of maintenance of contraction; 3 to 4, period of relaxation.

then went forward with, at first, an accelerating, then a decreasing, rapidity until the maximum of contraction was attained. This position was maintained several minutes, when a relaxation occurred by which the organ was restored to its original position. In comparison with the long familiar reaction of the frog muscle-nerve preparation, it will be seen that in one the latent period is about one hundredth of a second, in the other thirty seconds; the period of contraction in one is five hundredths of a second, and in the other twelve hundred seconds; the period of maintenance of contraction in one is momentary, and in the other it endures eighteen hundred seconds; the period of relaxation is five hundredths of a second in one, and thirty-three hundred seconds in the other.

The essential features of the mechanism of each of the two movements are so widely different that these are not capable of strict mutual interpretation, but in general the rapidity of con-

traction in plants may be said to be less than in animals. It must be borne in mind that the mechanism of each has developed the rate of movement best adapted to its needs, and that this rapidity of movement is, furthermore, conditioned by the metabolic activity of the organism which supplies the necessary energy.

In recapitulation it may be said that the primal irritability of protoplasm has been developed in the motile, destructively metabolic animals through the phases of reflex into sensorial action, while in the fixed, constructively metabolic plants the main line of advance has been, not toward sensorial action, nor along a line parallel to it, but at a wide angle from it, into a series of highly specialized forms, whose delicacy of mechanism and efficiency is as commensurate with the complex necessities of the plant as those of the sensorial apparatus to the animal.

THE SPIRIT OF MILITARISM.

By A. B. BONNE.

IN the Principles of Sociology (Volume I) Herbert Spencer draws a sharp and clear distinction between two types of society—the militant and the industrial. Leaving out of consideration the analogy between the animal and the social organism in the development of the various systems—the regulating, the sustaining, and the distributing—it will be readily conceded that from the view of sociology the last of these two types—the industrial—stands highest in the scale of development as implying voluntary co-operation among the members of the organization with more of individual liberty; while the first, the militant type, implying compulsory co-operation under a more or less despotic military government with less of individual liberty, is decidedly nearer to the early predatory state. Mr. Spencer also shows how social metamorphoses take place. Especially interesting to note is the transformation or retrogression of the industrial type, partially developed during years of peace, into the militant type when war once more occurs.

Of all the illustrations which might be gathered from history, ancient and modern, as exhibiting this social transformation, Mr. Spencer considers that furnished by England in more recent years the most striking, because the industrial type here was further developed than anywhere else, owing in a great measure to the long era of peace which commenced in 1815. But the usurpation of power by Louis Napoleon in France caused a great change. England soon found herself involved in actual wars, one after the other. The threatening attitudes of neighboring nations alone

were sufficient to develop a similar one at home for the sake of defense. A structure for defense, however, is also available for the purpose of offense, and reasons for extending the empire never being scarce, England entered upon an era of aggressive warfare in various parts of the world. This, what Mr. Spencer calls a revival of the predatory spirit, was naturally accompanied by a return toward the militant type in the institutions generally—that is to say, "the extension of centralized administration and of compulsory regulation."

If Mr. Spencer were now to rewrite the Principles of Sociology, there can be no doubt that he would find in the United States an illustration scarcely less striking. Most of what he tells us of the changes in England is a matter of history here. That the immediate result of the late war of rebellion was a tendency of the military officialism to take the place of civil officialism no one will deny; and though it may, perhaps, not be said that we have military heads of all the various departments, still, the disposition to fill all administrative offices with military chieftains, so strong immediately after the war, was in the same line—the result being "a style of administration which asserts authority more and regards individual claims less." At the same time, the revival of the predatory spirit in regard to external affairs has been clearly discernible here too; for although the sin of aggressive warfare on weaker or barbarous nations can not be laid at the door of our Government, the constant cry for coast defenses and for the strengthening and increasing of army and navy are clear indications of the same spirit. But what chiefly must strike us as familiar facts are these: The spirit of sanitary dictation and the usurpation of exclusive privileges by certain professions (prominent among them the medical); poor-law, and we may add tramp-law, administration in various parts of the Union; the demand for municipal distribution of water, gas, and coal, as well as for governmental ownership of railroads and telegraphs; the ever-increasing influence of "a coercive philanthropy" invoking state power to improve people's conduct, etc.; in short, the strong impetus imparted to the socialistic tendency of modern times is nothing but that same military spirit clamoring for the right of the state, or the commonwealth if you please, to regulate the private affairs of the citizen in every department of life.

That this tendency is a real one, with roots deep down in the economic conditions of the masses, it would be useless to deny. Whether it as such is a healthful one, to be hailed with delight and encouraged, is another question—a question that does not come within the scope of this article; but as far as it is animated with the spirit of militarism it may well cause us alarm and misgivings. What shall we say, for example, of the movement, now

fairly under way in the State of New York, to establish throughout the country a system of military drill in the public schools and colleges? At a time when so much is heard about Germany groaning under its military system, rigorously maintained by its young war lord, this announcement ought to be well calculated to make every unassuming, liberty-loving American rub his eyes in wonder and ask whether he is dreaming or not. Many there are, no doubt, who will look upon it with a smile as a mere fad, perhaps good-naturedly regard it as a means toward the improvement of the general deportment and physical conditions of the young. But if they for a moment will consider the source from which it springs and carefully weigh the reasons with which it is launched forth, it surely must take a more serious aspect. The fact alone that it originated in G. A. R. circles, is backed and indorsed by certain high military dignitaries, civil functionaries, and legal authorities ought to arouse a suspicion in the ordinary citizen of a supposed free industrial country. It is, however, when we examine the arguments in its favor by some of these high military and legal authorities that its real essence, its military and retrogressive spirit, becomes clear.

In the first place, there is the usual soldier's argument that "if ever an occasion should arise when a call to arms should again be sounded, those to respond (having been trained in the schools to military tactics and to the use of arms) would be tenfold more efficient than were, at first, the brave boys of '61 and '62, who mostly went to the war practically undrilled." To this it only needs to be said that, the business of the professional soldier being to kill, it also becomes part of his business to find or devise new occasions for the exercise of his professional duties. It is significant of the extreme plight in which the military authorities find themselves in this respect that the gentleman, an officer of high rank, who gave utterance to the above warning could find no other possible occasion for the call to arms than "the anarchistic and socialistic forces tending to undermine our democratic republican government." Whatever influence, therefore, he may exert on the timid and the unthinking, to the philosophical, the trained minds, who recognize that these anarchistic and socialistic forces are the natural effects of real causes in our industrial and political conditions, to these his suggestions will have the weight of the professional soldier's pleading for his own existence and no more.

But the burden of argument in favor of this proposed military training of our boys and young men is that it will make them better citizens of this free country—that "a vote in the hands of a man who has been taught to love his country, and to recognize the value of obedience to law, and *to toe out and hold his chin up*

by military instruction, is a safe vote for the country." And here Germany is called upon to furnish an illustration of the cherished object. It is seriously asserted that the military system there is worth far more than it costs, for the reason that the young men there, through the several years of military drill and discipline, are made "efficient citizens for all the duties and emergencies of life."

It would seem strange indeed that in a country as young as this, with its Revolutionary antecedents, the sophistry of such arguments should not be apparent to every one at first sight, did we not know that very few appreciate the fact that in all ages it is disobedience rather than obedience to existing laws which has made progress possible; that each age or generation, yes, each new decade, has its own requirements; as the poet says, "must have new men to determine its liberty." If love for country means the obedience to civil and political law which a military discipline inculcates, then let us have less of it. One need not be a student of history to see the results of that kind of loyalty. Already now practical men may be heard every day discussing absurd laws with their far-reaching results; but they will add that a law must be respected at any cost until it is repealed, and as it does not come within their province to repeal it, the law remains, a menace to the liberties and happiness of the people. What must we expect, then, when every one shall have been trained into a military—that is, blind—obedience?

And here it may be well to ask, What is law, that we should cultivate this filial spirit toward it? Let it be understood that the common law, that by mutual consent established respect for life and property, is not here under consideration. The industrial type of society, where *voluntary association* is the rule, owes its growth to the comparative absence of military discipline, and it is just such a state of society where we find the respect for common law best developed. Statute law, then, is what we have to consider. Is this the spontaneous expression of the will of the people or of the best elements among us? Hardly ever. Now, whether it is the will of one or a few, enforced upon the rest through intimidation or strength of arms, etc., or whether it is the will of that always uncertain quantity, the majority, enforced by hook or by crook upon the so-called minority, why should it be held as something inviolable or something holy? Even if we were to take the most optimistic view of law, should regard it as the expression of our own will, "the voice of the whole people," we would by no means be in duty bound to cherish it as something inviolable. That we erred yesterday is no reason why we should continue the error to-day. Or, to leave error out of the question, if we at a former occasion acted according to the light given us then, so, with the increased experience of to-day, let us

act according to our present light and disregard what under this must be incomplete or inadequate. Some will here undoubtedly interject the popular notion that in a supposed free country the people have it in their power to repeal useless laws whenever they choose; the facts do not seem to bear out the statement, but, let that be as it may, as already hinted at, the inculcation in the minds of the young of military obedience to law must certainly make the chances for repeal more and more hopeless.

Now, what do they mean, they who seriously argue that if we are to preserve our free institutions we must rear a generation of men "who have a wholesome respect for discipline, a habit of obedience together with an enduring love for flag and country which can not be uprooted by every passing storm of modern *isms*"? What do they mean by saying that a vote in the hands of such is a safe vote for the country? In the mouth of Emperor Wilhelm such words and sentiments are perfectly consistent: his power lies in the obedience of his subjects. But free institutions and a servile spirit can never go hand in hand. Free institutions can only be maintained by the eternal vigilance of the individual men and women, whose power of deciding between right and wrong is strengthened by free play and exercise. Change, ceaseless change, is the essence of life in superorganic as well as in organic bodies. Evolution and dissolution, growth and decay—this is the immutable order everywhere. If freedom and liberty are dependent on institutions, then clearly these must be changeable, for, once they become fixed and stagnant, freedom to act is out of the question. If this be not so, what is the meaning of "a vote in the hand of a freeman"? And what is the meaning of many of our symbols of liberty? At the harbor of New York city was erected the Statue of Liberty as "a pharos light to the weak endeavor." Could this mean simply that the citizens basking in its light should cultivate a submissive obedience to what once was decreed as best for them? Was it not rather intended as a reminder of the fact that liberty can only thrive with a distrust toward the old and a spirit ever ready to adapt itself to the new?

The promoters of this movement can only have this in view: The desirability of securing for our country a population of well-drilled subjects whose business shall be, not so much "to reason why" as it shall be "to do and die"—"to toe out and hold their chins up" when orders are given. When we remember how largely, already now, legislation is dictated by concentrated capital or by various interests intrenched behind governmental protection, how it is influenced by religious or superstitious prejudices; when we remember how conservative these controlling forces from their very nature must be toward everything that

modern science, speculative and experimental, teaches, then the reactionary spirit of the movement becomes startlingly clear, and then, perhaps, will we understand the poet, who, speaking for the Goddess of Liberty, said:

"I am a threat to oppression's sin.
And a pharos light to the weak endeavor.
Mine is the love that men may win,
But lost—it is lost forever!"

JOURNEYING IN MADAGASCAR.*

By FRANK VINCENT.

EARLY on the morning of September 10th I left Antananarivo for Mojanga. My chief reason for not returning to Tamatave was that I preferred to see new country; and the second, that I wished to visit some gold mines worked by a Frenchman, named Suberbie, who had a concession of a large tract about halfway between the capital and the coast. This gentleman has a house in Antananarivo and spends much of his time there. I had the pleasure of meeting him and he favored me with letters of introduction to his manager at one place and a mining engineer at another. The bulk of my baggage had been left in Tamatave, and was to be sent on by the next monthly French mail steamer to Zanzibar, my ultimate destination. I expected to meet a like steamer at Nosy Bé, a French port and island on the northwest coast, with which I learned I might connect by means of a small French steamer which periodically served the principal ports on the west coast of the island. By thus crossing Madagascar I hoped to familiarize myself with its three great races. The Sakalavas on the western portion of the island have always borne a bad name, which they have in part merited, though high-handed aggressions of foreigners ought often to be urged in mitigation thereof. I was warned to keep my revolver in readiness and my escort near at hand, and so determined to take chances of a safe passage to the sea. The direct distance from the capital to Mojanga is two hundred and forty miles in a general northwest direction, though this distance, by many deviations and changes of level, is lengthened by the traveled route into about three hundred and eleven miles. Of this latter distance some two hundred miles are by land in filanzana and the remainder by water in pirogue and dhow, or small sailboat. The total journey may readily be accomplished in ten days. The country through which I would have to pass was

* Extracted from the author's latest book of travel, entitled Actual Africa, recently published by Messrs. D. Appleton & Co.

said to divide itself naturally into three sections: the first was similar to that eastward of the capital, a treeless region of moors and hills. This was the most inhabited. It consisted of four broad terraces which fell rapidly toward the sea. The road, however, leading as it did obliquely across these terraces, presented on the whole easy gradients. Then came a section of nearly uninhabited wilderness, wooded and undulating. The third section contained the cultivated hills and plains of the Sakalavas. I reengaged for this journey four of the filanzana-bearers and the captain, Mazoto, who had come up from Tamatave with me. This Mazoto was a bright, intelligent fellow, who, besides being the chief of the men, acted as my body servant, and assisted me in cooking and the general duties of vagrant housekeeping. He was born in the country, but of Mozambique parents. His descent showed itself very clearly in his curly hair, his features, and his manner. I then engaged four more filanzana-bearers and six baggage coolies. This made a following of fifteen persons. I took a little larger stock of provisions, but otherwise the outfit was quite the same as when coming to the metropolis from Tamatave. I hired my men only as far as the land journey extended, and was therefore obliged to pay one half more for their return, which seemed no more than just. The bulk of this payment was arranged to be made when they arrived in Antananarivo, and I promised them each also a small present to be earned only by faithful attention to duty and good behavior—so that by these means I had the men pretty well under control. And now it was necessary to call the roll of my assembled bearers and coolies, and this was no easy or quick matter, for scarcely one name was of less length than six syllables. Biographical names in Malagasy are quite as long as geographical. Two of the men were slaves belonging to Mr. Ryder's clerk. In appearance they could not be distinguished from the others, and in amiability and faithful work they proved rather superior to them. All the names, singularly enough, began with the letter R. Here are some of them: Rataimiandra, Ramahamay, Rainivelonandro, Rainizanakolona. The baggage was soon packed in three parcels, and covered with tarred cloth for fear of stray showers. These parcels then being lashed to thick bamboo poles, each borne by two men, were sent on in advance. My filanzana stood waiting, and after a hasty but none the less heartfelt parting from my kind entertainer, I "mounted" and started away north through the deeply gullied streets of the capital, past the edge of the great Zoma, by the tomb of the prime minister's family, and down on to the great plain of Betsimitatatre, covered as far as the eye could see with variously tinted rice fields and everywhere traversed by large and small canals of water obtained mostly from the Betsiboka River. The large canals are utilized by boatmen in

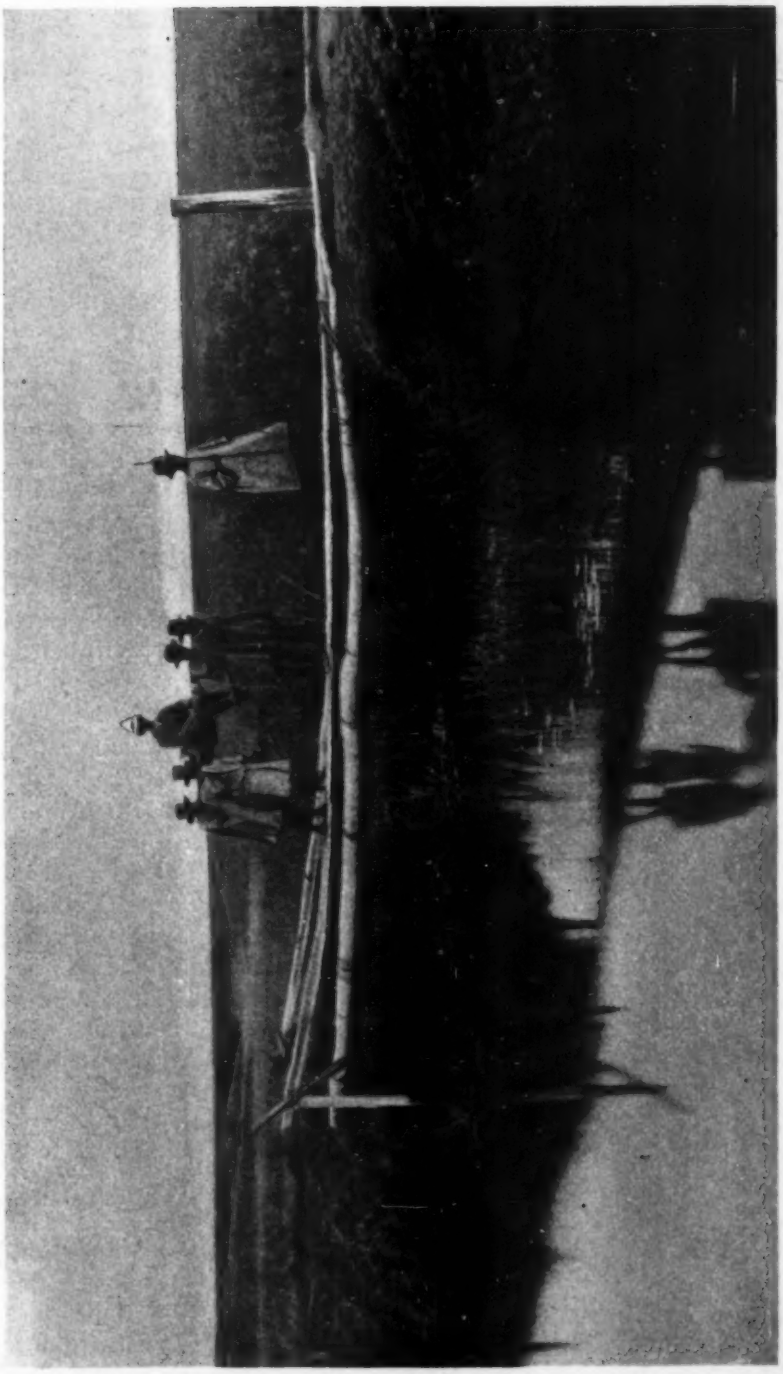

FIG. 1.—ON THE ROAD IN FILASANA.

bringing their supplies in canoes to market. Squatting by the banks of many of the rice fields were natives armed with guns with which to kill the numerous birds that eat the young growing rice.

The Betsiboka River is here about fifty feet wide in the dry season, but so high and powerful does it become in the wet season that it has to be restrained in its bed by a huge levee of earth some fifty feet in width. On the top of this lay our road for many miles. The other great embankments crossing the plain were nearly covered with mud-walled dwellings. We next reached the banks of the Ikopa, here only a muddy stream about fifty feet wide but one of the largest rivers of Madagascar, whose general course I was now to follow, though at some distance to the eastward, until I reached the sea. I soon left the plain and entered upon a country similar in general character to that found east of the capital, except that the treeless moors were smoother and the road far better. For a long way I enjoyed fine views of Antananarivo, sitting proudly upon her Acropolis, and then, crossing a high ridge, she was gone, to be seen by me no more. Afterward we passed at some distance a great bazaar or weekly market like the Zoma of the metropolis, being held on the top of one of the great smooth downs. The thousands of white shrouded figures collected there were a queer sight. I stopped to eat my lunch in a little roadside hut, and rested upon a comfortable mattress made of palm-leaf ribs and covered with straw matting. On the wall hung a sort of fiddle, with two strings stretched upon a small gourd. The doorway of this hut was only three feet in height, and I had almost to go on "all fours" in order to enter. A very old decrepit woman was the only one about, though I had noticed others in other huts. The sole occupations of these poor old creatures consist in sitting in the sun and gazing at nothing, or, while lying half asleep on a mat, in driving chickens from the rooms with a long pole or with simple hisses. As the doors are always wide open and the fowls always in search of scraps of food, the crones are not idle, at least when inside the huts. No one seems to pay any attention to these reminiscences of humanity, and they themselves appear to wait only for reluctant Nature to dissolve. Going on, there were many outcroppings of granite now to be seen and many curiously shaped erratic bowlders. One hill looked like the round dome of an observatory, another like an ordinary haystack. Everywhere possible rice terraces were placed, and there were many small cultivated fields, but before night the country had become quite deserted, and the road after those to which I had been accustomed was positively lonesome. The strong, pitiless wind which unobstructed sweeps these moors added to this feeling. Traveling at this season is very trying also, for as you sit so long in your filanzana you are chilled and

Fig. 2.—Malagasy Canoes.

FIG. 3.—THE TRAVELER'S PALM.

cold until midday, then positively roasted until about four in the afternoon, when you again feel cold until your fire warms you at night. You must have a fire, for, although the houses hereabouts are built of mud bricks, they are by no means tight about doors and roofs. While I was in Antananarivo the weather was cool and delightful morning and evening, perhaps a trifle too warm in the middle of the day only. But the air was always clear and bracing, and there was generally a light breeze blowing.

Many of the hamlets were now surrounded by a deep ditch, a huge fence of cactus, and a very wide low wall. They reminded me at once of pictures of scenes in central Africa. The ditch generally has some sort of drain, for fear of its overflowing during the heavy rains of the wet season. The ground within the inclosure is quite smooth and level, and the houses usually stand in two rows right and left of the low and narrow entrance gate, which is partially closed by a great stone slab or by piles of logs. I stopped for the night in one of these villages, and was shown quarters in a wretched hut half full of pigs. That is to say, I was offered a room adjoining the pigsty, into which the door of the house directly opened, while the people scrambled into the dwelling room by a window about two feet square, to which they mounted by a pile of rough stones. Upstairs there was a dirty kitchen, to which you had access from the pigsty by a flight of dark, narrow, steep steps in which there was a turn at right angles, for otherwise the house was so small the steps would have had to be vertical. Adjoining this kitchen was a room just large enough to contain my camp bed, and this I accepted—fleas and all—for, if I had to be in the same house as the pigs, at least I preferred another *étage*. All these villages seemed to allot a large portion of their ground floors to a horrible little black and white spotted pig. The infrequency of pigs on the east coast is more than balanced by their frequency in the central districts.

We continued on during all the next day in a sort of rough valley bordered by ranges of hills. The soil was poor, the grass was coarse, and there was much red clay. The country was very thinly settled and few people were met upon the road. I stopped for my lunch in one of the circular, ditched villages, in a very dilapidated dirty hut in which the only door, as usual, opened directly into the pigsty, while the family scrambled through a little bit of opening several feet from the ground. To facilitate the exit of smoke two large holes had been made at either end of the roof. This let in some daylight, which was much needed, but looked as if much unneeded rain must enter by the same orifices. In the center of the room next the piggery was a fire, and against the walls a few cooking utensils, a rice mortar and pestle, a basket of young squawking ducks, some rolls of matting, and a few clothes.

Fig. 4.—Some Styles of Hair-dressing.

In one corner sat two little bright-eyed boys who were studying from some paper-covered books—their readers and spellers. I observed that they had also a catechism and a small Testament. All were of course in the Malagasy language. They had also a slate which was used for writing their exercises. I took a little stroll afterward among the houses, and was surprised and amused to see how frightened the chickens were at my approach. I had expected this of the few curs about, but hardly of the fowls. The hens exhibited the greatest alarm, and strove to marshal and drive away their chickens. Apparently even a glimpse of civilization, as represented in my humble self, was altogether too much for these creatures, so naturally more distrustful than their owners, who cheerfully look at everything foreign but will adopt nothing.

During the afternoon we passed through the large village of Ankozobe, pleasantly situated on a smooth hill, like the whole country hereabouts entirely devoid of trees. The people burn a small reed for their cooking, and charge the same price for this as for firewood. Just outside the capital a great field is covered with huge bundles of this reed, there kept for sale. Nearly all the houses of Ankozobe were built in the shape of wall tents—i. e., they had mud walls two or three feet high, upon which directly rested the high-peaked grass roofs. The governor came from his house to invite me to rest and partake of some refreshment, but I was obliged to decline his hospitality, wishing to reach a certain town before dark. This was called Ambatvarana, with deep, wide moat and a square full of cattle. Pigs swarmed everywhere. Just to the westward was a magnificent great mass of gneiss, with precipitous sides showing vertical striæ which looked like the basaltic columns of the Giant's Causeway of Ireland. The range ends a little to the northward of the village in a vast dome of gneiss, with a big conical top which itself rises all of a thousand feet above the roughly undulating plain. It is called Mount Angavo. The highest point is said to be 4,880 feet above sea level, or about one hundred feet above the site of Antananarivo. I visited several houses in this village that were tendered me, but each seemed worse than the other. Finally, I accepted a room in one, on condition that the pigs should sleep away from home for that night. After putting up my camp bed and mosquito-netting, I found I could not get in all my very limited baggage and myself at the same time unless I suspended the most of the former from the walls, which accordingly I did, having driven wooden pegs into the interstices of the mud bricks. The upper floor into which the family were crowded was reached by a vertical bamboo ladder. Soon after lying down for the night I heard so much noise in the pigsty that I was afraid my hostess had forgotten her promise. On searching I did not, it is true, discover any pigs, but there were a cat, a litter of pups, and

a brood of chickens. These, at least at my distance, did not smell, and I supposed would not indulge their respective vernaculars all the night, so I returned, decided to make the best of the situation. But little did I know that by no means had a complete roster of

FIG. 5.—NATIVE SOLDIERS.

the inmates been taken. I found long before morning that the place swarmed with vermin of all sorts: lice, fleas, mosquitoes, bugs, cockroaches, spiders, and even scorpions. I arose at 2 A. M. and wished to take to the road at once, but had not the heart to waken my tired men before five. Within an hour we were off.

SURVIVALS OF SUN-WORSHIP.

By FANNY D. BERGEN.

WHEN happy boys and girls sing, "Here we go round the mulberry bush," or "Oats, peas, and barley grow," and gracefully step time to the words as they circle round and round, they dream not that in these and other ring games they often keep alive survivals of ancient sacred ceremonies. When some careful housewife tells her daughter or servant to be sure to stir cake or beat eggs in the same direction in which she begins, neither the matron nor her assistant has the faintest notion that this rather general rule in domestic affairs may be the survival of some very old religious rite. In this brief paper no attempt will be made to trace definite relationships between trivial customs of to-day and their ancient prototypes, or to draw any serious conclusions from the few miscellaneous illustrations that I have here and there picked up of the dextral and the sinistral circuits. I simply add them for what they may be worth to the mass of material on the subject that is gradually being accumulated by ethnologists. All sorts of unexpected survivals of old religious observances constantly appear in common everyday life. They are but degraded, tattered remnants of what ages ago were dignified, sacred rites. Considering how English-speaking folk have inherited influences from a great variety of sun-worshiping peoples, it would not be strange if there were found among them many outcrops of a worship that has been, and still is, in some form or other extremely widespread among primitive peoples. The early trading and colonizing Phœnicians, the Druids, the North German and Scandinavian invaders, all have left traces of their religious customs confusedly intermingled with Christianity. In dealing with the origination of actions or customs in which is involved what Dr. Fewkes calls the ceremonial circuit,* it is difficult to determine the value of the factor, whether it be large or small, that is due to the greater convenience of moving in a right-handed direction. Occasionally the dextral circuit is followed in cases in which it is evidently less convenient than the sinistral would be, as in dealing cards in all ordinary games. Also who can tell just how large or small an element may depend upon the tradition that the left hand in itself is uncanny without reference to the sun's apparent motion? There certainly is a general feeling of wide distribution that to be left-handed is unfortunate. Dr. Fewkes's careful and valuable researches among the Moki Indians of Arizona, however, show without doubt that they in

* Journal of American Folklore, vol. v, No. 16, p. 33.

their religious rites make the circuits sinistrally—i. e., contrary to the apparent course of the sun, or, as physicists say, contra-clockwise. The Mokis also are careful to stir medicines according to the sinistral circuit. But countless instances go to show that among Asiatic and European peoples the general belief or feeling is that the dextral circuit—i. e., clockwise, or with the apparent motion of the sun—is the correct and auspicious direction.

The following illustrations of this I quote from William Simpson's Meeting the Sun:* "They [people of past times] held that going sunwise was good and lucky, while going the opposite way was unpropitious. The Lama monk twirls his *mani* or praying cylinder in one direction on this account, and he fears lest a stranger should get his wheel and turn it the other way, thus destroying whatever virtue it had acquired. They also build piles of stones, and uniformly pass them on one side in going and on the other side in returning, thus making a circuit in imitation of the sun. The ancient *dagopas* of India and Ceylon were also thus circumambulated. The Mohammedan performs the '*tawaf*' or circuit of the Caaba after the same fashion; and it is an old Irish and Scotch custom to go 'Deisul,' or sunwise, round houses and graves, and to turn their bodies in this way at the beginning and end of journeys for luck, as well as at weddings and various ceremonies."

To turn the opposite way was called by them "withershins," and supposed to be an act intimately connected with the purposes of the evil one. Witches danced this way, and in imitation of the same read prayers backward. The author of Olrig Grange, in an early poem, describes this most graphically:

"Hech! sirs, but we had grand fun
Wi' the muckle black deil in the chair,
And the muckle Bible upside doon
A' ganging withershins roun' and roun',
And backwards saying the prayer.
About the warlock's grave,
Withershins gangin' roun',
And kimmer and carlins had for licht
The fat of a bairn they buried that nicht,
Unchristened beneath the moon." †

The Imperial Dictionary gives the derivation of the word withershins as from the Anglo-Saxon *wither*, against, and *sunne*, the sun—that is, contrary to the motion of the sun—though I believe there has been some disagreement regarding the origin of the word. It is sometimes spelled *widershins*, which would imply a direct relation to the German *wider* and *schein*. Withershins movements were generally used in working spells or counter-

* Pp. 340, 341. † Confessions of Annaple Gowdie, from The Bishop's Walk.

charms. It was an old popular belief in the Highlands of Perthshire that if on Hallow-eve one were to go alone around one of the fairy hillocks nine times withershins (*sinistrorsum*), a door would open by which he could enter the subterranean abode of the good people.*

In Joseph Jacobs's version of the fairy tale of Childe Rowland it was because in seeking the ball lost by her brothers in their play their sister Burd Ellen ran around a church withershins that the fairies carried her away. Also, when the third brother seeks her in Elfland, it is by following the direction given him by the hen-wife—viz., to go three times withershins around the fairy hill—that he obtains entrance to the Dark Tower, from which he safely carries the long-lost sister and the two elder brothers.†

As contra-sunwise motions were thought to be of ill omen or to be able to work in supernatural ways, so it came to be believed that to reverse other acts—as, for instance, reading the Bible or repeating the Lord's prayer backward—might produce powerful counter-charms. The negroes in the Southern States often resort to both of these latter practices to lay disturbing ghosts. In the ring games of our school children they always move sunwise, though whether because of convenience or from some forgotten reason who can say?

The weight of authority concerning the English May-day festivities and ceremonies goes to prove that their origin was in the old Roman Floralia, but there is some evidence to show that such celebrations are at least in part of Gothic origin. I suppose that there is little or no doubt that the northern European nations did welcome the return of the spring sun with dancing, and Brand quotes Borlase as stating that the May rejoicings in Cornwall are a gratulation to the spring. The old Beltane games and dances—so named from a corrupted spelling of the compound derived from the Phœnician word *Baal*, the sun, and the Gaelic word *tein*, meaning fire—that were practiced in Perthshire and other parts of Scotland until the beginning of this century, contained many survivals of sun-worship.‡

Lady Wilde says that the Beltane dance in a circle about a bush hung with ribbons and garlands, or about a lighted bush or a bonfire, celebrating the returning power of the sun, is still kept up in parts of Ireland on May-day, and that those taking part in the dance always move sunwise.* It seems highly probable that

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* Dr. Grahame's Scenery of the Perthshire Highlands, quoted by Scott in notes to Lady of the Lake, canto iv.

† English Fairy Tales, p. 117 *et seq.*

‡ See Napier's Folklore in the West of Scotland, pp. 161–170.

* Ancient Cures, Charms, and Usages of Ireland, p. 106.

the Celtic May-day ceremonials and customs were of quite different origin from those of England, and in many small superstitions concerning May-day we find among the Irish peasantry frequent hints at sun-worship or of the worship of fire, the symbol of the sun. It is still believed to be unsafe or even profane to carry fire from one house to another on May-day; and on that day, when evil-minded persons or witches have special power, the butter in the churn may be protected from bewitchment by placing a live coal under the churn.

Undoubtedly the most remarkable survivals of sun-worshiping festivals in modern Europe are the Christmas rejoicings, which are but a Christianized relic of the old Yule celebration, marking the occurrence of the midwinter solstice, and the merrymaking on St. John's eve, which is merely an adaptation of the midsummer fire-festival of pagan times. In our own country the latter occasion passes unnoticed, but Christmas is sufficiently observed.

It is a general popular belief throughout the United States that in making cake the eggs, or indeed the whole mixture, must be stirred or beaten from beginning to end in the same direction in which the stirring began, or the cake will not be light, and that a custard will curdle if the stirring motion is reversed.

This superstition is still current even in households where a patent egg-beater is used, which is so constructed that its loops of wire revolve in opposite ways at the same time; and, although the result is most satisfactory, the belief in the old rule of stirring "only one way," or in a dextral direction, is unshaken. Often it is said that the stirring must be sunwise, the popular expression for this dextral motion being "with the sun." The same notion is found in Newfoundland; and a woman from Aberdeen, Scotland, tells me that it is a general belief among her countrywomen that, to succeed in any household work where either stirring or rubbing is involved, the movement should always be "with the sun." Some matrons in northern Ohio say that to insure good bread the dough should be stirred "with the sun," and that yeast should be made as near sunrise as possible to secure lightness. It is also a common saying that if, after turning the crank of a churn for a time sunwise (the most natural way for a right-handed person), it be turned backward, all the work done will be undone. The same superstition is found in Newfoundland. In southern Sweden cooks will tell you that, in beating butter to a froth or in making gravy, the stirring must continue as begun, to secure good results; and in eastern Massachusetts I find that the superstition extends even to the processes of making ice-cream and molasses candy. The notion that lye soap will not "come" —i. e., saponify—unless it is stirred "with the sun" is more or less current in localities where this old-fashioned industry is yet car-

ried on; and in parts of the South you will be told that if the soap be stirred backward it will turn to lye. I have been told that wheelwrights, in greasing the wheels of a wagon or carriage, are in the habit of beginning with a certain wheel and going round the whole vehicle in a set way.

In New Harbor, Newfoundland, it is customary, in getting off small boats, especially when gunning or sealing, to take pains to start from east to west, and, when the wind will permit, the same custom is observed in getting large schooners under way. So, too, in the Western Isles, off the coast of Scotland, boats at starting are, or at any rate used to be, rowed in a sunwise course to insure a lucky voyage.

Many persons in our own country are yet careful to have a new house placed exactly with the points of the compass, no matter whether or not by so doing the building is made parallel with the street which it faces. Occasionally one sees a front yard of an awkward three-cornered shape for this reason, though with practical Americans the idea of the necessity of having the house placed with the meridian is now losing ground. However, in older countries the subject of orientation has been much heeded in planning buildings, especially temples and churches. The east has been the auspicious direction, or that to which worshipers faced in many Asiatic countries, in pagan Rome, and in the early though not the earliest centuries of the Christian Church. In the old imperial palace in Kyoto the eastern gate is used for ceremonial purposes; the southern one is a general entrance; on the western sides there are several miscellaneous gates; but the northern gate is never opened save when a funeral passes forth, and under the old *régime* the same custom prevailed to a certain extent among the nobility. In general, the north is considered by the Japanese an unlucky direction, probably because it is thus that the dead are carried out for interment. In a Masonic lodge the master is stationed at the east end of the room, and if his place be not the geographical east it is so called.

It is a very common saying among card-players that if one's luck is poor he may change it by rising, walking around his chair three times, lifting the chair, and then resuming his game. An old love divination that comes from southeastern Ohio was as follows: Go after dark to an unoccupied house and throw a ball of yarn into it through a window; hold the loose end of the yarn in the hand, then pass three times around the empty house, winding the yarn, meantime repeating: "I wind and who holds? I wind and who holds?" Upon coming to the window the third time the questioner of fate will see the apparition of his or her future spouse. Another love divination from Alabama, or "project," as such charms are called in various parts of New England, is on

May morning to look into a spring that runs to the east, when the face of one's destined husband or wife will appear. If, however, the one trying the charm is to die unmarried, a coffin instead of a face will be seen.

The idea of sunwise movement often appears in folk medicine. Before the days of massage, in rubbing for rheumatic or other pains in Concord, Mass., it was thought best to rub from left to right—i. e., dextrally. A central Maine cure for ringworm is to rub in a sunwise direction about the diseased spot with a finger moistened with saliva. A Pennsylvania-German prescription says that a corn, wen, or other excrescence may be removed by rubbing "with the moon" if by night, and "with the sun" if by day. It is thought that the sun or moon, as the case may be, will draw away all pain and enlargement. Alabama negroes believe that a "conjurer" can rub away a "rising" (boil) by coming to your bedside about daybreak, before you have spoken to any one, and rubbing the inflamed surface for nine successive mornings. A reputed cure for biliousness among the negroes of the Eastern Shore of Maryland is to bore three holes in a tree, around which the patient is to walk three times as he repeats: "Go away, bilious. Go away, bilious." *

It will be noticed that in several of these cures, as well as in some of the charms already cited, no rule is given as to the direction to be followed in movement; but it is quite possible that the original description was more explicit, and it is almost certain that in every instance a sunwise course would now be followed.

A remedy for a "curb" in a horse, in northern Ohio, is to rub the curb with a bone at the going down of the sun. This smacks of the doctrine of signatures, as well as of sun lore. In the same region, some years ago there lived a Pennsylvania-German small farmer. He was somewhat known in the neighborhood as a charm doctor, and children who had been burned sometimes went to him to have him "blow the fire out," and strangely enough, as I know by personal experience, the pain would disappear as he with his breath blew upon the smarting spot, meantime softly mumbling to himself. This man's cure for what is popularly known as the sweeny in horses was to rub "with the sun" every third morning until there was relief.

An Alabama superstition is that if the head of one dying be turned to the east his death will be easier. The subject of orientation as applied to the position of the dead, both before and after

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* In the province of Moray, in Scotland, hectic and consumptive diseases were thought to be cured by putting parings of the nails of the fingers and toes of the patient in a rag cut from his clothes, and then waving this parcel thrice round his head, crying, "*Deas soil.*" —Shaw, History of the Province of Moray, quoted in Brand's Popular Antiquities, iii, 286.

burial, is too complicated and extended to be more than barely referred to here, in connection with a few interesting customs still prevalent or lately extant in this country or in Europe. Examination shows that headstones in the old burial grounds of Plymouth, Concord, Old Deerfield, and Rutland, Mass., face the west, so that if the dead could rise to a standing posture they would face the east, long associated "with light and warmth, life and happiness and glory." It is customary among the Irish peasantry in County Cork to lay the dead "to be waked" in a similar position, as well as to dig the grave east and west. These customs are directly derived from the usage that prevailed through mediæval times of digging the grave east and west and placing the head toward the latter point, a practice which doubtless was an outgrowth of the legend that Christ after death was thus laid. Rev. J. Owen Dorsey has found that the Indians of the Kansas and Omaha tribes place the dead with the head toward the east,* consequently no living Omaha will lie in this position. According to Schoolcraft, the Winnebagoes buried their dead in a sitting posture with the face west, or at full length with the feet west, "in order that they may look toward the happy land in the west." † An interesting observation made by Mr. Dorsey is that in singing one of their sacred songs the Kansas Indians were accustomed to raise their left hands, beginning at their left with the east wind, then turning to the south wind, then to the west wind, and last to the north wind, thus completing the dextral circuit. So far as I can gather from the writings of Schoolcraft and others, and from some questioning of experts in Indian customs, there would seem to have been no one rule common to all the North American tribes with regard to the position of the grave with reference to the points of the compass. Some preference for the east-and-west position seems to have existed among certain tribes, but their mode of interment was often modified to suit the contour of the land about their villages.

In a religious observance called "paying rounds," much practiced by the Irish peasantry, one finds an interesting instance of the dextral circuit. "Rounds" are paid for the cure of any disease or ailment, either by the person afflicted or vicariously for him by his mother, if living, or, if not, by some near friend. Servant girls in the United States, when ill, sometimes write home to Ireland and have rounds paid for them. The required rites may be performed at the grave of some holy priest, perhaps one who in his day wrought miracles, or at the grave of a priest who, before dying, gave directions that it would be right and fitting there to

* Mourning and War Customs of the Kansas Indians. American Naturalist, July, 1885.

† Schoolcraft, Indian Tribes, part iv, p. 54.

pay rounds to cure pain or sickness; or sometimes the place selected is a tomb where a saint has appeared, and not infrequently it is one of the "blessed wells"—e. g., the "well of the Blessed Virgin" in the parish of South Kilmaurray in County Cork, where are still shown in a rock near by the print of Mary's fingers and the dint left by the pressure of her knee as she once in her lifetime knelt there in consecrating this well. The mode of procedure in paying rounds at a grave is first to kneel at the foot and repeat a rosary, then to rise and kneel at the right shoulder of the one buried there and repeat another rosary, then to the head and repeat another rosary, then to the left side and repeat a fourth rosary. The person performing the rounds must next go to some neighboring well, whose water is never to be used for any other purpose, and fetch a cup of it to the grave. Into this cup of water he drops a pinch of earth taken from the grave, saying, "In the name of the Father"; then another, saying, "In the name of the Son"; then a third, saying, "In the name of the Holy Ghost." The one who is paying the rounds next goes behind the headstone of the grave, taking the cup of earth and water, and, if the disease to be cured is an external one—e. g., erysipelas—pours a little of the contents of the cup upon the affected part of the body and so bathes it, and also pours a little of it on the ground. If the disease is an internal one, a little of the liquid from the cup is swallowed. What remains of the earth and water is now to be poured back on the portion of the grave from which the earth was taken. Five *paters* and five *aves* are then to be said, after which the ceremony is concluded for the time by placing some "token," which may be a cup, a button, or a small coin, on the grave. Where rounds have been paid for many years, the grave is thickly covered with these tokens. After the first rounds have been completed, the whole ceremony must be repeated twice more, the only suitable day for the observance being Friday or Sunday. In some instances three times three rounds are vowed and paid. If the prescribed rites are gone through with at a holy well, the one seeking relief kneels at four different places around the well, always making the circuit, as at a grave, in a sunwise direction. Instead of leaving a token, the devotee, at each of the four stations, with a pebble scratches a cross on one of the top stones of the well wall.

It is said that it is customary among the Scottish Highlanders, when visiting a consecrated fountain or well, either to bathe or to quench thirst, to make the circuit sunwise.

TIMOTHY ABBOTT CONRAD.

By Dr. CHARLES C. ABBOTT.

IN Philadelphia, early in the present century, there was a strongly developed taste for natural-history pursuits, and eager collectors of the local fauna naturally became so acquainted and thrown together that the formation of a club and then the organization of the Academy of Natural Sciences were the logical outcome. Previous to this, local zoölogy had not been overlooked, as the quartos of the American Philosophical Society show, and Peale's Museum was also an incentive to natural-history studies; but all was more or less chaotic until the academy came into existence. Then fresh enthusiasm was roused and every member became a collector, and every collector a describer of new species. To-day these old naturalists would irreverently be called "species mongers"; but if possibly there was a little less "science" in their labors, all credit is due them for excellent intentions, and every evidence of careful, correct, and valuable work, which has not had to be done over. Looking back to the time when Say, Nuttall, Rafinesque, Lesueur, Vanuxem, Troost, Harlan, Morton, and Conrad filled the pages of the academy's journal, we get a glimpse of a remarkable company, who collected eagerly and studied carefully their "finds" and spicily defended their positions when the great question of "priority of publication" came up. These men were not given to theorizing; evolution was not in their vocabularies, although we see at times some evidence of looking beyond a species to its real significance. De Maillet's strange book had been translated and informally discussed, but, as a general thing, no one troubled himself with Lamarck, or all accepted Cuvier without question. In short, these Philadelphia naturalists gathered specimens all day, and when they had the material sat up all night describing new species. And among them all there was no one more eager in the quest and more popular with his fellows than Solomon White Conrad, the father of the subject of the present sketch. That the elder Conrad was a remarkable man all who remember him assert without reserve. That he was a popular one, the fact that his house was a favorite gathering place for all the scientific notables of the city clearly proves. His was the first natural-history *salon* opened in Philadelphia, and being a matter of six days in the week, instead of at stated intervals, was fully as popular as the celebrated Wistar parties.

A descendant of Thones Kunders (subsequently anglicized to Dennis Conrad), who left Crefeld, Germany, July 24, 1683, and settled at Germantown, then nine miles from Philadelphia, but now in the city limits, like his American ancestry, Solomon W.

Conrad was a strict Quaker and an approved minister of that faith. His father was John Conrad, a blacksmith, and Solomon was born July 31, 1779, and died October 2, 1831. Of his early life nothing is positively known, but it is probable that he was apprenticed to a printer or bookseller. It is known that a strong fancy for scientific study was early developed, and the fears of his friends were realized that he would not be successful in business, because of attention divided between his shop and his cherished specimens at home. His partner ruined him financially. His herbarium is now in the possession of the Philadelphia Academy of Natural Sciences. As evidence that the country was more attractive than the shop on Market Street, I quote the following from the manuscript journal of a nephew: "My father, . . . with Solomon Conrad, would take long walks in search of new specimens. I went with them once on a stroll along the banks of the Schuylkill, when they saw at the same time, in the shallow bed of the river, a fine lot of mussels. Both rushed to the spot, regardless of the rough stones and splashing of the muddy water, the broad tails of their plain coats standing out behind and their arms reaching out in front, eager to secure the prize." In the spring of 1829 Solomon Conrad, who at that time had acquired a wide reputation as a mineralogist and botanist, was elected Professor of Botany in the University of Pennsylvania, and delivered, May 1st, his introductory address. In The Friend of fifth month, 9, 1829, the late Roberts Vaux, of Philadelphia, gives the following estimate of the lecture: "With a succinct review of the history of botany he very happily blended some biographical notices of the distinguished men to whom the science owed its origin and illustration. He traced with great acuteness and perspicuity the analogy of vegetable and animal life, admitting the limit of human knowledge. Every view that he furnished of the subject, upon which he is so well qualified to impart instruction in all its details, was just and forcible, while the simplicity of his manner and chasteness of his style were by no means the least interesting traits of the lecturer." The venerable Frederick Fraley, Esq., of Philadelphia, recently informed me that he was present at the introductory lecture referred to, and that Mr. Vaux had in no wise allowed his enthusiasm to outrun his discretion.

On June 21, 1803, when his father was but twenty-four years old, TIMOTHY ABBOTT CONRAD was born. His mother was then staying at the home of her father, four miles from Trenton, N. J., in Burlington County, New Jersey. To this birthplace young Conrad became so strongly attached that he yearly made pilgrimage thereto, even when no representative of the family lived there. In his purely literary writings he so frequently refers to the place that he was once twitted about it, but without effect.

"Timothy," remarked an old Friend, "was thy grandfather the only man who ever lived in the country?"

"Other men *exist* in the country, but no one else *lived* like my grandfather," he replied.

Brought up, when with his parents, in so scientific an atmosphere, and when at his birthplace so delightfully surrounded not only by congenial kinsfolk, but Nature in her most attractive guise, it is little wonder that Conrad became a naturalist. Mr. Fraley tells me that, when a youth in early teens, Conrad was the "president" of an "Academy of Science" of which he, Mr. Fraley, was "secretary," and that it was conducted with all the decorum and good faith of the institution after which it was modeled.

Conrad was educated at select schools under the superintendence of Friends, but really educated himself, so far as the "higher branches" were concerned, acquiring without a teacher a thorough knowledge of Latin, Greek, and French. His skill in drawing was remarkable and early developed. He not only made all his own illustrations, but did considerable for others, as the shells, seaweed, and other small objects on some of Audubon's plates of birds. Before seriously taking up the special studies that subsequently made him famous, he wrote many sketches of a popular character, and occasionally drifted into verse. His father being a publisher and printer, Conrad entered the establishment as a clerk, reluctantly probably, and there learned the printer's art, and when his father died, in 1831, he continued the business for a short time, but the love of natural history was too strong to be overcome, and he gave up the shop and its belongings. Because of a preference for walking afield to attending religious services, a committee of Friends called upon Conrad, and, not accepting his explanation, they directed his name to be stricken off their roll of membership. Conrad did not like their action, and probably it is due to this that he seldom afterward attended any religious gathering, occasionally dropping into some country Quaker meeting, but always, as he said, for old times' sake and not spiritual profit.

In 1831 he was elected a member of the Academy of Natural Sciences, and, some years after, of the American Philosophical Society. Of many foreign learned societies he was a correspondent, but, keeping no record of such elections, the names and dates of election have been lost.

Conrad's first volume bears date of 1831, and has the following title: American Marine Conchology, or Descriptions and Colored Figures of the Shells of the Atlantic Coast. Of this little volume, printed for the author, Conrad says in his preface, "it is designed to supply a deficiency which has long been felt by the cultivators of American natural history." The work contains seventeen

plates, all drawn by the author, and colored by hand by his sister. In 1834 Conrad published New Fresh-water Shells of the United States, with Lithographic Illustrations and a Monograph of the Genus *Anculotus* of Say. Also, A Synopsis of the American Naiades; Philadelphia, Judah Dobson, 108 Chestnut Street, May 3, 1834. The full title of this little volume, with precise date of publication (not much larger than the title is long) is given, because even then questions of priority had arisen, and others laid claim to some of Conrad's species. This unhappy wrangling was kept up for many years. Prof. Dall refers to this, as we shall see further on, as "numerous controversies, which are now ancient history." Conrad's own version should be given. He claimed that the editions of his publications were largely bought up and destroyed by a worker in the same field, and this explains the rarity of some of his writings. In the preface of the little volume above mentioned the author says: "While residing in the mansion of my kind and hospitable friend, Judge Tait, of Claiborne, Alabama, where I was employed in collecting the organic remains of the vicinity, I occasionally made excursions up and down the Alabama for the purpose of procuring fresh-water shells. I have succeeded in obtaining some species which I believe to be new, and hope to fix by accurate delineations and descriptions." The result was the little book, which is dedicated to the late Charles A. Poulson, of Philadelphia, a prominent conchologist in his day, and one of Conrad's financial backers in his several expeditions south in search of both recent and fossil shells. In 1834, in the Journal (old series) of the Philadelphia Academy of Natural Sciences, Volume VII, Conrad published Observations on the Tertiary and More Recent Formations of a Portion of the United States, which appears to have been his first communication to that body. In 1841 the Proceedings of the Academy were commenced, and a new series of the Journal in quarto. In the former, from Volume I to Volume XXXVI, Conrad's contributions appear in every year; the articles varying from two to a dozen in number. In the first four volumes of the new journal he has eleven contributions, all of which are profusely illustrated. In 1836 Conrad published Monography of the Family Unionidæ, or Naiades of Lamarck (fresh-water bivalve shells), of North America. Illustrated by Figures drawn on Stone from Nature. Philadelphia: J. Dobson, 1836. This work, like the Marine Conchology, was never finished. It would seem as if the magnitude of the work had not occurred to him at the time, or that he was soon tired of any subject that he took up, but the real difficulty was a want of financial support. There were never enough subscribers to meet the expense of publication. At this time, too, his health was very bad, and he seemed to lose

all interest in every undertaking. "A period of moping would usually end in his writing some verses which nobody would praise, and this seemed sufficiently to nettle him, to rouse him thoroughly, and he would become again enthusiastic in the matter of shells and fossils."

In 1837 Conrad was appointed Geologist of the State of New York, and after resigning the position remained as paleontologist of the survey until 1842. "He prepared official reports on the fossils collected by the United States exploring expedition under Wilkes; by Lieutenant Lynch's expedition to the Dead Sea; by the Mexican Boundary Survey, and some of the surveys for a railroad route to the Pacific undertaken under the supervision of the War Department. Many papers were written by him on the Tertiary and Cretaceous geology and paleontology of the eastern United States and published in the American Journal of Science, the Bulletin of the National Institution, the American Journal of Conchology, Kerr's Geological Report on North America, and other publications. A list of Conrad's papers, which covers most of those bearing on paleontological topics, may be found in Miscellaneous Publications of the United States Geological Survey of the Territories, No. 10; Bibliography of North American Invertebrate Paleontology, by Drs. C. A. White and H. Alleyne Nicholson—Washington, Interior Department, 1878. It contains a hundred and twelve titles" (Dall).

In 1832 Conrad published Fossil Shells of the Tertiary Formations of North America. Illustrated by Figures drawn on Stone from Nature. Vol. I. Philadelphia, 1832. It is dedicated to Samuel George Morton, M. D. In 1838 Conrad published Fossils of the Tertiary Formations of the United States. Illustrated by Figures drawn from Nature. Philadelphia: J. Dobson. These are known generally as the Eocene and Miocene volumes, and both, as original editions, are extremely rare. They have recently been reprinted in facsimile: the former by Mr. G. D. Harris of the Smithsonian Institution, Washington, D. C.; and the latter by the Wagner Free Institute, under the editorial supervision of William H. Dall, of the National Museum. In his introduction Prof. Dall says: "Students of the American Miocene and the later Tertiary deposits of the New World are well aware of the importance to them of Conrad's work, usually referred to by the title of The Medial Tertiary. There can be little doubt that the scarcity of this work and its predecessor, the Eocene volume, is the chief cause of the delay in investigating our rich and interesting Tertiary beds."

Prof. Dall, in considering Conrad as a paleontologist, remarks as follows: "Mr. Conrad had several peculiarities; he wrote his letters and labels frequently on all sorts of scraps of paper, gen-

erally without date or location. He was naturally careless or unmethodical, and his citations of other authors' works can not safely be trusted without verification, and are usually incomplete. He had a very poor memory, and on several occasions had redescribed his own species. This defect increased with age, and, while no question of willful misstatement need arise, made it impossible to place implicit confidence in his own recollections of such matters as dates of publication. He himself says in a characteristic letter to F. B. Meek, written in July, 1863: 'I go on Monday to help H—— ferret out my skulking species of Palæozoic shells. May the recording angel help me! God and I knew them once, and the Almighty may know still. A man's memory is no part of his soul.'

"In spite of this constitutional defect, Conrad had an acute and observant eye, and an excellent, if sometimes hasty, judgment on matters of geology and classification. He was in advance of his time in discriminating genera, and in field researches and work on the specimens showed more than ordinary capacity. In those branches of his work which required knowledge of literature and systematic research he took less interest and pains.

"Like many shy people, he was brought rather than ventured into numerous controversies, which are now ancient history, and need not be further alluded to. But the sketch just given will enable readers to understand the origin of much that is irritating to those who are obliged to rely upon Conrad's work and find in it slips and errors so obvious that they seem unpardonable. He had the defects of his qualities, but whether for good or evil he was the principal worker in the field of Tertiary geology in America for many years. He has left a voluminous literature, and neither his faults nor his virtues can by any method be ignored."

When Darwin's Origin of Species was published, Conrad became intensely interested in the discussions that wonderful book provoked. He did not take the theory up as subject-matter for an essay; but contented himself with innumerable notes and memoranda that I found on loose slips of paper after his death. He was bitterly opposed to evolution; considered Agassiz the world's greatest naturalist, and predicted that Darwin's "wild speculations" would soon be forgotten. Every geological age came, Conrad held, to a complete close, and the life of the succeeding one was a wholly new creation. These utterly crude and untenable views he held to, to the last.

It would be unjust to the memory of the subject of this sketch to pass over without notice his characteristics as a man and author. Conrad was something besides a profound paleontologist. This his friends well knew; but for the writer of this sketch to

deal with this phase of Conrad's personality is a rather delicate matter. As his nephew, I might say too much; as his biographer, I wish not to say too little.

Conrad was of small stature, thin and homely, yet he had, as an intimate friend recently said, a refined countenance. There was a kindly light in his eyes that words can not describe nor the cunning of the artist depict. I have said "homely"; this on his own authority, for in his poem The Watermelon he declares:

> "The poet may sing of the Orient spices,
> Or Barbary's dates in their palmy array,
> But the huge rosy melon in cold juicy slices,
> Is the Helicon font of a hot summer day,
>
> "Where I bathe the dry wings of the spirit, and sprinkling
> Sweet drops on the pathway of dusty old Care,
> I hold Father Time from his villainous wrinkling
> Of features that never had graces to spare."

As a conversationist, Conrad had few superiors, but a weakness of his voice made it difficult for him to be heard, and it was only when with two or three intimate friends that this quality shone out. He avoided large gatherings and never spoke in public. He had a keen sense of humor and was an inveterate punster. His memory was "very bad" scientifically, says Prof. Dall, but it was remarkably good so far as poetry was concerned, and when walking alone in the country he would repeat aloud long passages from the works of his favorite authors. His fondness for poetry led him to writing verses, some of which were printed in the Philadelphia papers as early as 1828; and his latest effort bears date of 1874. In 1848 Conrad published The New Diogenes, a Cynical Poem. This is well described in the subtitle. It consists of some twenty-five hundred lines of fault-finding. The edition was very small and is not yet exhausted. In 1871 the writer undertook to bring together the scattered short poems, and found thirty-two of these, mostly in the corners of newspapers and two in manuscript. The little volume was "privately printed." It bears the title, A Geological Vision and Other Poems. Trenton, N. J., 1871.

In his non-scientific writings Conrad invites a comparison with Thoreau, but, while loving the outdoor world as devotedly, he always had an eye to physical comfort, and preferred, at the end of a long tramp, a good bed at a tavern to sleeping out of doors. So too, probably, did Thoreau, but then to say so does not sound so prettily in a book.

Timothy Abbott Conrad died in Trenton, N. J., August 9, 1877, the last of the prominent group of early Philadelphia naturalists, who paved the way for the more philosophical biologists of the present day.

CORRESPONDENCE.

EVOLUTION IN 1858.

DEPARTMENT OF BIOLOGY, COLUMBIA COLLEGE,
NEW YORK, *April* 11, 1895.

Reviewer of the Greeks to Darwin:

DEAR SIR: I regret that I do not see the Monthly regularly. A friend has recently called my attention to your review of the Greeks to Darwin, and I write to ask you to consider the following points:

The history ends absolutely with the publication of the theory of Natural Selection by Darwin and Wallace in 1858, therefore has no bearing upon the subsequent development of the evolution theory. The bibliography, also, is exclusively a bibliography of critical and historical articles upon the pre-Darwinian evolution. Where titles are of more recent date, they simply refer to recent historical and critical notices. This being the case, Herbert Spencer's position is simply treated as that which belonged to him previous to 1858; and if you will read his two earlier essays in comparison with Lamarck's Philosophie Zoologie—a large work of two volumes, fully expounding and expanding the evolution theory—I think you will see that I have done Herbert Spencer full justice.

Herbert Spencer, after 1858, as in his remarkable application of the evolution theory to all departments of thought, of course deserves a very high position, second only to Darwin, and this position I accorded him in the same course of lectures for the Columbia students, in treating of the Post-Darwinian Period. The fact that I barely consider any of Darwin's later work renders it evident that the omission of Spencer is not in the nature of a slight, but simply that his work did not come within the limits of the period treated. I fully understand and appreciate the peculiar features of Spencer's contributions to the evolution theory, and have myself contributed extensively to the Neo-Lamarckian literature in this country which is the Spencerian side; at the same time I can see many weak points in Herbert Spencer's biological system, and his rank in the future as a theoretical evolutionist is closely tied up with that of Lamarck in the question of the transmission or nontransmission of acquired characters.

Trusting I have made this matter clear, I am, Very truly yours,

HENRY F. OSBORN.

[If the contents of Prof. Osborn's book agreed with its title—From the Greeks to Darwin—we might be able to accept the above excuse as valid. But since the work devotes fifteen pages to tracing the progress of Darwin's thought down to 1881 we fail to see the justice of disposing in as many lines of what has been done by a contemporary, who is the acknowledged master in the broader field which includes Darwinism.

Even if Prof. Osborn were correct in stating that "the history ends absolutely with the publication of the theory of Natural Selection by Darwin and Wallace in 1858," it is easy to show that he has not done justice to Mr. Spencer. Before that time Spencer had published his Social Statics (1851) and Principles of Psychology (1855), showing the working of evolution in social and mental phenomena respectively. He had also published twenty magazine articles, now to be found among his collected essays, or as chapters in his later books, in all of which the development hypothesis is unmistakably the keynote. More important than the single one of these that Prof. Osborn mentions is Progress: its Law and Cause (1857), in which Spencer states the nature of the process of development, with illustrations from all fields of activity. Furthermore, the implication in the above letter that Spencer has merely extended the application of what Darwin announced in 1858 deserves a word. The prospectus of Spencer's Synthetic Philosophy was printed in March, 1860. It has been reprinted since 1880 in the American edition of several of his books, with a note over the initials E. L. Y. from which the following testimony may be taken: "In 1854, he [Mr. Spencer] arrived at the conception of evolution as a universal process of Nature." Referring specifically to the prospectus: "The writer has seen a still earlier manuscript form of this Prospectus, embracing seven volumes instead of ten, but laying out the same subjects in the same order and by the same method, that was written out and became a matter of private correspondence in 1858." Prof. Hudson, in his Introduction to Spencer's Philosophy, corroborates both these dates, and states that the plan for the series of books was formed while Spencer was writing his Nebular Hypothesis, an essay published the day after the date of the journal containing Darwin's and Wallace's historic papers. The real relation between Spencer and Darwin is that the latter worked out independently one division of the great scheme elaborated by the former.—EDITOR.]

A PREDICTION OF THE PHONOGRAPH.

Editor Popular Science Monthly:

SIR: Your note in the February number of The Popular Science Monthly on Roger Bacon's dream of the steamship

tempts me to send you another curious illustration of how extraordinary geniuses in times past sometimes foreshadowed in their writings the marvels of a later era in the world's affairs. Of all the latest wonders of man's ingenuity, the phonograph would seem to be at least one that was not subject to the dictum of Solomon, "Nothing new under the sun"; and yet, a few months ago, while amusing myself with Cyrano de Bergerac's Histoire comique des États et Empires de la Lune et du Soleil (Paris, 1660), I was amazed to come across the matter quoted below, which surely foreshadows the phonograph as closely as do Bacon's words the steamship and railway.

The author (De Bergerac) is on a voyage over the moon. Left alone a little while by his guide, the latter gives him, to help him while away the hour, some books to read. The books, however, are different from any seen on earth. They are, in fact, little boxes, which Cyrano thus describes:

"On opening one of these boxes I found I know not what kind of metal (apparatus) similar to our clockwork, composed of I know not how many little devices and imperceptible machinery. It was a book, certainly, but a most marvelous one, which has neither leaves nor characters; a book to understand which the eyes are useless—one needs only use his ears. When one wishes to read this book he connects it by a sort of little nerve to his ears. Then he turns a needle to the chapter that he wishes to hear, and immediately there emerges from the instrument, as from the *mouth of a man, or from a musical instrument*, all the words and sounds which serve the *Grands Lunaires* for language."

I will say, further, that Cyrano anticipated many of the inventions and conceptions of modern aëronauts. No wonder that he was considered by his contemporaries as "somewhat off," or, as the French say, as a *cerveau brulé*.

FRANK L. JAMES, Ph. D., M. D.

ST. LOUIS, *February* 28, 1895.

EDITOR'S TABLE.

THE GROWTH OF ANTHROPOLOGY.

WHEN in the seventies Prof. J. H. Gilmore introduced the study of anthropology into the curriculum of the University of Rochester he was probably the only instructor in the subject in America. Since then the science has made rapid progress. Agencies for its dissemination and the aid and encouragement of its students have greatly multiplied, so that to-day the science of Man is taught by specialists, and holds a prominent place in many of our leading educational institutions. Among these are the universities at Toronto, Worcester, Chicago, Cambridge, Philadelphia, Lewiston (Bucknell), and Washington (Columbian). Besides these, as Chamberlain has recently shown, teachers, mainly occupied with some other subject, also give instruction in anthropology at Yale, Leland Stanford, Western Reserve, Indiana, Oberlin, Dartmouth, Bowdoin, Wisconsin, Brown, Illinois, City of New York, Johns Hopkins, Massachusetts Institute of Technology, Vassar, Cornell, Lake Forest, Vermont, Kansas, Tufts, Minnesota, Michigan, and Ohio. To this considerable list should certainly be added Wellesley, and probably Union and Mississippi. The list grows, and only a few days since the University of California was announced to introduce anthropology among its subjects for teaching. At most if not all of the institutions where special teachers are engaged in the work there are laboratories for research and practice, and at least beginnings of museums. This is great progress for twenty years, and much more may be expected during the next decade. A subject so important must rapidly force itself into all the prominent institutions of higher learning.

The university instruction reaches

but a small part of the community, but the interest in anthropology extends far outside of the classroom. Courses of public lectures are astonishingly well attended. Prof. Putnam at Cambridge, Dr. Brinton at Philadelphia, Prof. Starr at Chautauqua, at New York, and at Chicago —have with others for some years past spoken to thousands and have helped to kindle a wide public interest in the subject. To-day the great peripatetic Associations for the Advancement of Science—American, Australian, British, French—all have their Section of Anthropology. Many know what a battle had to be fought in at least one of these associations for recognition of the newcomer. To-day it is not only present, it dominates. No other section of the American Association draws to its public meetings as does this one; nor is it surpassed in the number of important papers presented. In the popular magazines of the day a constantly increasing amount of space is given to papers in some one or other division of the science. In the various science series a full share of volumes are anthropological. Thus, it has been noticed that in the Contemporary Science Series nearly all the volumes are devoted to the science of man, and every one has observed the great number of valuable works in this field in the International Scientific Series. And just now, apparently in response to a demand, two other series have been started, the one devoted to anthropology generally, while the other deals with that important subdivision of the science which makes the criminal the special object of study.

Museums of ethnography and archæology increase. In no part of the world are they quite wanting. The Museum of Gizeh in Egypt is superb, for study; that at Tiflis in the Caucasus is rich; at La Plata in the Argentine Confederation is a vigorous young institution, with a good anthropological department; at many of the small capitals of Mexican States are choice series of antiquities. In this matter the United States lags somewhat; but at Boston (Cambridge), Salem, New York, Philadelphia, Washington, Chicago, Davenport, St. Louis, and San Francisco are collections of significance which are open to the public. The last comer in this group is the Field-Columbian Museum at Chicago, with an excellent department in anthropology under the curatorship of Prof. Holmes.

Anthropological societies are not numerous in America. Work in some direction is done in connection with State and local historical societies and State academies of science. Such local societies as the New York, Chicago, and Davenport Academies of Science have Ethnological Sections. Specific Anthropological Societies exist at Washington and New York. The Anthropological Society of Washington publishes an official organ of value. The Woman's Anthropological Society in the same city has been active. Interesting societies, including study and social features, are those at Yonkers, N. Y., and at Brookville, Ind., both of which have had regular meetings at short intervals for several seasons. Of societies which devote themselves to a single phase of work, there are many, among the most interesting of which are the folklore societies. The American Folklore Society meets annually and at various places, but its branches—at Montreal, Boston, Philadelphia, New York, New Orleans, etc.—hold regular meetings at stated times. The Chicago Folklore Society—now the International Folklore Association—holds month-

ly meetings, and has branch societies in Minnesota and Tennessee.

The governmental work in anthropology can not be well overestimated. The National Museum, the Smithsonian Institution, the Army Medical Museum, and the Bureau of American Ethnology are doing much by displays, lectures, publications, and field work. Of field work by outside organizations more than ever before goes on. The Peabody Museum Exploration in Honduras, the Bandelier Expedition to South America, the Mexican work of the American Museum of Natural History and other organizations, the Armour Expedition to Yucatan, and the Hemenway Exploration in the Southwest testify a widespread interest.

There is no question, then, of interest and activity. These are world-wide, and steadily increasing. The real need now is direction of this interest to the best end. It is necessary to so organize and systematize efforts in each department, and in the whole field, that the man of ordinary intelligence may know the meaning of the movement, and come in touch with it profitably. Helps are not entirely lacking. There are journals—the American Anthropologist, American Antiquarian, Archæologist, American Journal of Folklore—these show the trend. Dr. Brinton's Current Notes in Anthropology in "Science" are helpfully directive. Dr. Fletcher's Quarterly Bibliography in the American Anthropologist, and Prof. Mason's Annual Summary of Progress in Anthropology throughout the World (published by the United States National Museum), keep readers informed of recent literature. With these aids the student has but to select his field. First of all, however, he will do well to read a few good books of a general kind. De Quatrefages's Natural History of Man, and The Human Species, Brinton's Races and Peoples, Tylor's Anthropology, Early History of Mankind, and Primitive Culture, are useful. Some of these are by no means recent works, but they will not soon be replaced.

CONCLUSION OF DR. WHITE'S NEW CHAPTERS.

OUR readers who have followed with interest Dr. Andrew D. White's papers on the Warfare of Science—and that they are many is amply proved by the constant stream of inquiries as to the publication of the series in book form which we receive—will be pleased to learn that the last division of the subject is now completed. As already announced, The Warfare of Science is to be published as a volume. While this final division is running through the Monthly, the author will continue his careful revision of the preceding portions, already well advanced, and by the time the last installment appears the printer will probably have begun putting the first part into book form. In his earlier chapters Dr. White has shown how theologians have been forced step by step to yield the domination which they asserted in astronomy, meteorology, medicine, and other fields outside their own province. He is now about to trace the advance from fantastic errors to more rational views which the spread of the scientific mode of thinking has compelled them to make in theology itself. This advance has been brought about not so much by direct action on the part of science as by the disposition which science has aroused in men to use their reasoning powers on all matters that are presented to them. The consequence has been that dogmatism and mysticism in preaching and teaching have found fewer and

fewer listeners, while the most intellectual ecclesiastics, feeling the same influence, have shrunk from the dogmatic and mystical extravagances of their predecessors.

LITERARY NOTICES.

DEGENERATION. By MAX NORDAU. D. Appleton & Co. 1895. Price, $3.50.

SEVERE diseases require severe remedies, and the rapidly increasing tolerance of literary, artistic, dramatic, and musical works that have a tendency to apotheosize various vices and defects of the higher mental faculties, demands the trenchant criticism that this volume affords. Years ago, in the comic opera of Patience, Mr. Gilbert satirized the impression created by the æsthetic vagaries of certain contemporaries in the lines—

"If this young man understands these things that are certainly too deep for me,
Why, what an exceedingly deep young man this deep young man must be!"

And too often the self-proclaimed prophet of some new dispensation in art or letters is taken seriously by a number of persons; and worse, in consequence of causes familiar to those experienced in the treatment of nervous diseases, finds a number of imitators.

Dr. Nordau, who is a pupil of Lombroso, has in this volume applied to certain writers and artists the same rigid rules of psychical investigation that were used by the Italian *savant* in his investigations into the factors and features of the degeneration of the criminal classes. Pronounced as the antithesis may be in a comparison of two such groups, there are yet fundamental points of resemblance that are depicted in this volume.

With tremendous diligence the author has perused the works of Rosetti, Swinburne, Verlaine, Maeterlinck, Tolstoi, Wagner, Peladan, Rollinet, Baudelaire, Friedrich Nietzsche, Walt Whitman, Oscar Wilde, Ibsen, Zola, and many other more or less known authors and artists, and he furnishes numerous quotations from their works to support his estimate of their mental condition. The characteristics of degeneration and hysteria manifest themselves "in mysticism, which is an expression of the inaptitude for attention, for clear thought and control of the emotions, and has for its cause the weakness of the higher cerebral centers; in egomania, which is an effect of the faulty transmission by the sensory nerves, of obtuseness in the centers of perception, of aberration of instincts from a craving for sufficiently strong impressions, and of the great predominance of organic sensations over representative consciousness; and in false realism, which proceeds from confused æsthetic theories, and characterizes itself by pessimism and the irresistible tendency to licentious ideas, and the most vulgar and unclean modes of expression."

In the last analysis there is in the degenerate a brain incapable of normal working, and its aberrant functions are manifested in feebleness of will, inattention, a predominance of emotion, a lack of knowledge, an absence of sympathy or interest in the world and humanity, and decay of the notion of duty and morality.

The author is not a pessimist; he does not believe that the degenerates will have more than an ephemeral existence and a limited following; that, like the dancing mania of the middle ages, a number of persons may be participants, but the majority of the people will be unaffected; and that true art and literature will still live and have their being when the whim and caprice of the moment have, like the iridescent soap bubble, broken, leaving nothing but some soapy moisture.

The volume is very interesting, and, while the author often writes with a vehemence that seems too prejudiced to be the expression of sober judgment, his arraignment of the accused and his evidences of their culpability justify his stern indictment.

The book is a strong one, and it is likely to prove suggestive and helpful to many who may think that the so-called art and literature of the future, as expressed by certain mentally defective individuals of to-day, are worthy of their careful study and imitation.

THE MAKING OF THE BODY. By Mrs. S. A. BARNETT. London and New York: Longmans, Green & Co. Pp. 288.

THE method of this manual is entirely novel. It is the outcome of practical expe-

rience in an endeavor to interest untutored minds in physiology. The effort was so successful in an English school among the poor that children and adults became eager to learn about the mechanism of the body.

The circulation of the blood, breathing, digestion, and sensation are described as journeys made by the blood, air, food, sound, and light; all technical names are translated into everyday English: the *peritoneum* is the over-all coat; the *thyroid*, the shield-ring. The terms employed are very ingenious and readily remembered; the stories apt and generally well founded. One, however, betrays a hasty generalization—an American girl burns her hands on a grate in England because in America *they only use closed stoves!*

Nevertheless, the book is an excellent one, and may be heartily recommended for home reading, as well as to teachers of elementary classes.

MR. HERBERT SPENCER ON THE LAND QUESTION. A Correction of Current Misrepresentations of his Views. New York: D. Appleton & Co. Pp. 30. Price, 25 cents.

A PROFOUND misconception respecting the difference between Mr. Spencer's original view concerning landownership and that he now holds having been widely diffused, he has thought it desirable to dissipate this misconception by a simple statement of what the original view was and what the present view is. For this purpose, besides a brief general statement in a preface of what his original doctrine was and what his views are now, and of the extent to which they have been modified, he reprints in parallel columns, Chapter IX of Social Statics, published in 1851, embodying the first published expression of his views, and pertinent extracts from Justice, published in 1891, embodying his latest published expression of them. He originally contended, he says, that the land could not become individual property, but was the property of the community, and that this is in fact the current legal doctrine, as illustrated in the theory of eminent domain. This doctrine he continues to hold, and has emphasized it in Justice, and strengthened it by numerous illustrative facts. With this assertion of the claim of the community to the land is coupled that of the private owner for compensation for the additional value he has given it when the state asserts its right. He contemplated, however, that the exercise of its claim by the community, under the condition stated, would leave a balance of benefit to it. If this were not the case, although he held the doctrine still good in absolute equity, he would in practice forbear the exercise of the right. Of late years he has become satisfied that the burden of compensation would outweigh the benefit of possession, if the compensation were anything like equitable in amount; and has therefore come to the conclusion that the change from private tenure to public would be impolitic. Furthermore, it has become clear to him that the prevailing assumption that the existing landowners hold from those who first seized the land and misappropriated it is untrue, and he has pointed out that among the people who are supposed to be robbed exist in large measure those who are descendants of the robbers. Hence the anger fostered against landholders is largely misdirected. These original views, as well as the modifications of them, are not at variance with the opinions held by the landed classes in England, but are views which they have themselves publicly enunciated through certain representative members of their class. The selections in parallel columns of the present pamphlet—which were first published for the use of the English Land Restoration League—are followed by a postscript, in which Mr. Spencer shows from authentic statistics that land in England is not all held by "dukes, earls, and baronets," but that an immensely larger proportion of owners possess but moderate quantities, and that those who possess small quantities are a hundred times in number those who possess great quantities. If equity requires that the large holders shall be expropriated, the same rule must apply to the small ones—in the majority of cases wage-earners—who have acquired their estates by hard work and self-denial in poverty. Does any one in his senses advocate this? Having made this demonstration, Mr. Spencer adds that the beliefs expressed in the essay—1, that a reversion to public landownership could not justly be effected without compensation to private owners; 2, that the making of compensation would bring more loss than

gain to the community; 3, that the equitable adjustment of compensation would be extremely difficult; and, 4, that the administration of the land as public property by state officials would entail all the vices of officialism—by no means involve the belief that private landownership should continue without change. Immense estates should not be allowed to be held in permanency; but a fundamental change in land tenure is not required for remedying this evil. In England, abolition of primogeniture will do it. Recognizing the right of the state to restrain the use of land in ways at variance with public welfare, we may at the same time hold that there are cases in which it is both politic and practicable to exercise that right. The publication frees Mr. Spencer beyond all doubt from any possible charge of inconsistency between the views formerly published by him and those which he has more recently expressed.

MEMOIR OF SIR ANDREW CROMBIE RAMSAY. By Sir ARCHIBALD GEIKIE, with Portraits. New York: Macmillan & Co. Pp. 397. Price, $4.

SIR ANDREW RAMSAY was one of the leaders in the geology of his time, and, by virtue of his pleasant and strong qualities, exercised a wide influence over his contemporaries. He joined the Geological Survey of the United Kingdom when it was still in its infancy, and remained on its staff during the whole of his active scientific career—a period of forty years. "So entirely," says Sir Archibald Geikie, "did he identify himself with the aims and work of the survey and so largely was he instrumental in their development, that the chronicle of his life is in a great measure the record also of the progress of that branch of the service. Recognizing this intimate relation, I have woven into my narrative such additional details as might perhaps serve to make the volume not only a personal biography, but an outline of the history of the Geological Survey of the United Kingdom." From the summary of Ramsay's work given by the author, it appears that his earliest and his latest labors—beginning with a pamphlet on the geology of Arran, and ending with the second edition of a monograph on North Wales—were in structural geology. "Between these two limits he accomplished a large amount of investigation directed toward the elucidation of the geological structure of Britain." His two presidential addresses to the Geological Society mark a distinct epoch in stratigraphical work, in that in them he indicated the historical meaning of the imperfection of the geological record which had been pointed out by Darwin. His physiographical work was abundant, remarkably original, and important, and bore on denudation in general, the history of river valleys, and the results of the operations of ice. Connecting his stratigraphical with his physiographical researches was a series of papers discussing the former existence of continents or of terrestrial conditions, during the deposition of the geological record. His principal contributions to the literature of the history of geology were two inaugural lectures at University College, and his address as President of Section C of the British Association of 1881, which embodied historical reviews. He was a thorough uniformitarian in his theories to the end. His literary work included criticisms and lively articles in the Saturday Review. A still wider view of the extent of his influence is afforded when it is recollected that for nearly thirty years he was a teacher of geology, that he was an able debater in the Geological Society and a brilliant lecturer, and that he had the practical training of men on his staff in the Geological Survey who have since become conspicuous in educational life.

THE EVOLUTION OF THE MASSACHUSETTS PUBLIC-SCHOOL SYSTEM. By GEORGE H. MARTIN. International Education Series. New York: D. Appleton & Co. Pp. 284. Price, $1.50.

Two very significant statements are made by the editor in his preface to this book. The inhabitant of Massachusetts receives, on an average, nearly seven years of schooling, while the citizen of the nation at large enjoys only four years and three tenths of such training. In the same State the average earnings apportioned to each man, woman, and child would be seventy-three cents per day; elsewhere in the United States this amount is represented by forty cents.

"There would seem to be some connec-

tion between these facts," warily observes Dr. Harris. Although the wealth-producing power may not represent the intellectual status of the individual, that it is proportional to the intelligence of a large community admits of scarcely a doubt, and for this the amount of schooling may stand as an exponent. Mr. Martin depicts the schools as passing through three stages of evolution. The earliest era, when the only object was to make a storehouse of the mind; the three Rs were deemed sufficient to fill it at an elementary dame-school; later the classics were added, and more recently grammar, geography, and the sciences. During this period the "child was to be held down and operated upon, or headed off when he obeyed an impulse of Nature." Secondly came the graded system, when the aim was to supply a measurable quantity of knowledge, to get per cents, and pass examinations. Thirdly emerged the modern school, which inquires into the child's nature and seeks to develop it. "Instead of viewing the new pupil as one more to be registered, put through geographies, arithmetics, and marked done, it recognizes an incipient man, and asks what the future may demand of him."

The new school is described as differing from the older in purpose and in spirit, studies, and methods of instruction. The work is so changed as to seem a revolution.

AMERICAN SPIDERS AND THEIR SPINNING WORK. By HENRY C. MCCOOK, D. D. Vol. III. The Author, Academy of Natural Sciences, Philadelphia. The set, $50.

DR. MCCOOK and all araneologists are to be congratulated on the completion of this able and conscientious work. And when we consider that this task has been accomplished in such odd hours and vacation times as a busy professional life affords, the fact that it has been completed seems little short of a marvel. The present volume contains six chapters similar to the contents of the two preceding volumes—i. e., dealing with various habits and activities of spiders. Among the topics treated in these chapters are the toilet making of the orb-weavers, the manner in which some of them burrow, their social habits, evidences of memory, feats of mimicry, the parasites that infest them or their cocoons, and a number of minor topics grouped under the head Biological Miscellany. Much of this material is supplementary to chapters in the two preceding volumes. Molting habits and the renewal of lost organs are considered at some length. Dr. McCook denies that the actions of spiders can be taken as indications of approaching weather changes, showing from his notes that the little weavers construct webs even that are destined to be destroyed within a few hours. He also puts on record some interesting superstitions regarding spiders, which need no refutation. Certain attempts to utilize spiders' silk commercially are recorded, but none of these have been economically successful. A second division of the volume consists of technical descriptions of genera and species of the orb-weavers, one hundred and twenty-three species being described. Following the index to the volume are twenty-eight colored plates, filled with figures of orb-weavers and of some of their organs, besides two plates of figures representing species of other aranead groups. There are also ninety-eight cuts in the text of the first portion of the volume. The present ascendency of that biology which occupies itself with examining microscopic portions of the dead bodies of animals seems to be decreasing the number of field naturalists who observe the phenomena and habits of living creatures. Let us hope that the latter side of zoölogy will not be too far neglected, and this handsome record of research seems to promise that it will not.

THE LIFE AND WRITINGS OF RAFINESQUE. By RICHARD E. CALL. Louisville: John P. Morton & Co. Pp. 227. Price, $2.50.

IN this sumptuous publication a much ridiculed and little understood naturalist is presented in the light afforded by a careful research. Besides an account of his life the volume contains a chapter on his personal appearance, with some discussion on the genuineness of the two portraits which are given in it. The part dealing with his scientific work tells of what he did in Sicily, in Lexington, Ky., and also takes up his investigations by subjects—conchology, ichthyology, botany, archæology, etc. A list of the medals, diplomas, and other honors conferred

upon him, and of the genera and species of plants and animals named after him, is given. There are also a bibliography of writings by or about Rafinesque, numbering over four hundred titles, and a copy of his eccentric will. Pages from two of his works are given in facsimile.

SCIENTIFIC FRENCH READER. Edited by ALEXANDER W. HERDLER, of Princeton University. Boston: Ginn & Co. 1894.

FOR twenty years past the necessity of a good reading knowledge of French and German by students of technical branches, as well as of pure science, has been recognized in our colleges. Very little progress has been made, however, in the matter of providing proper introductory language lessons for such studies. The present book must now be added to the still too short a list of books available for this purpose.

There are many difficulties in the preparation of such a book; for not only is linguistic knowledge necessary, but also technical knowledge covering all subjects treated, otherwise a correct vocabulary can not be appended to the book. Mr. Herdler has had the assistance of several well-known teachers of science in the proper rendering of these technical French terms into English, which insures their correctness in the connection in which they are used in the text.

The matter in the book consists of well-selected short articles, increasing in difficulty with progress through the volume. It will be found of greatest use to engineering students, chemists, and electricians, as the application to practical life of scientifically constructed devices is mainly treated. It will probably be a long time before special students in the departments of astronomy, meteorology, geology, zoölogy, etc., will have prepared for them books of this class which will enable them to acquire in a few months a technical vocabulary which now requires years of reading in special science literature.

COMMON SENSE APPLIED TO WOMAN SUFFRAGE. By MARY PUTNAM-JACOBI, M. D. New York: G. P. Putnam's Sons. Pp. 236. Price, $1.

IN this strong argument on the natural rights of women, Mrs. Dr. Jacobi has embodied the substance of what has been urged by past advocates of the "emancipation of woman," and by the leaders of the present movement, and has supplemented it with some forcible considerations of her own suggesting, which are commended to those who are interested in the subject. Of the author's ability to make the strongest presentation of the "woman" question, and of the worthiness of whatever she may have to say to be carefully and respectfully considered by candid men, there can be no question. A lady of high scientific attainments and of wide general culture, she has thought long and well on this subject and the others kindred to and connected with it. The address she made in favor of woman suffrage before the recent New York Constitutional Convention fell before an unsympathetic, timid audience largely governed by political exigencies; now she appeals to a different audience, which, though it may be unwilling, will not be afraid, if it sees fit, to move in the direction she wishes.

MISSOURI GEOLOGICAL SURVEY. Vols. IV and V. Palæontology of Missouri. By CHARLES ROLLIN KEYES, State Geologist. Jefferson City: Tribune Printing Company. Pp. 271 and 266, with 56 Plates.

THIS report includes the notes prepared by the former State Geologist for publication, embracing the results of the observations of himself and his assistants and correspondence, and the additional information that has been acquired under the present administration of the survey—the whole being carefully rewritten or revised. The material on which it is based has been gathered by members of the survey or found in local cabinets, private collections, and the cabinets of colleges and public museums. The author aims to present, briefly, an index to the fossils of the State by means of which the forms can be recognized easily, with a bibliography of Missouri palæontology, a summary of what has so far been done in it, and an introduction to more comprehensive faunal studies, tending toward a solution of stratigraphical problems more or less obscure. As a rule, all the species described have passed under personal observation. The disposition to fabricate or imagine "new species" has been resolutely checked, and attention has been turned in preference to

the discussion of the morphological relations and stratigraphical significance of the fossils. Brief nominal histories have been appended to the descriptions of many of the most important species, together with some of the most salient points brought out in the present investigation concerning the structural features of the various types. In illustration, the leading Missouri species of each genus have been figured, and also some of those forms heretofore described from the State, but never illustrated. Besides the consideration of the fossils, the stratigraphy of the State is described in an introductory chapter, and a geological map is furnished. In the present volumes animal remains are represented. The fossil plants are to be described hereafter. The work is thoroughly well done.

A HISTORY OF THE UNITED STATES. By ALLEN C. THOMAS, A. M., Professor of History in Haverford College, Pennsylvania. Boston: D. C. Heath & Co. Pp. 410 + 72. Price, $1.25.

THIS is a convenient and useful handbook of American history. The volume is profusely illustrated, including some excellent portraits of our distinguished men. Prof. Thomas has condensed within very narrow limits nearly all the essentials of our nation's story. His aim has been to muster the main facts, and impartially deal with events, the causes of which are briefly but clearly brought before the reader's mind. Though the details of great battles are omitted, the causes that led from time to time to hostilities are disclosed, and the best authorities are often cited.

A recent publication of the United States Department of Agriculture is a *Monographic Revision of the Pocket Gophers*, exclusive of the species of *Thomomys*, by Dr. *C. Hart Merriam*. It is a pamphlet of 258 octavo pages, illustrated with nineteen plates, four maps, and seventy-one figures in the text. Excepting part of the first chapter, less than twenty pages, it is composed of the most technical sort of biological material, absolutely unintelligible to ninety-nine per cent of the farmers for whose information it is ostensibly published. The author, who is Chief of the Division of Ornithology and Mammalogy in the department, explains its appearance in these words: "In preparing a bulletin on the economic relations of the pocket gophers it became necessary to determine the status and geographic distribution of the various forms. This study developed the fact that the group was sorely in need of technical revision. The present paper is the outgrowth of an attempt at such a revision. It has grown so far beyond the limits originally intended that a large genus (*Thomomys*) has been of necessity omitted and will form the subject of a subsequent paper." So it seems that another volume like this is threatened, and meanwhile the farmers must wait for what may be of some use to them—the economic account, which, the author tells us, "will appear as a separate bulletin prepared by my assistant." The biological information in the bulletin before us has its value for science, but it is an imposition to pay for its collection and publication with money that the people have devoted to the advancement of agriculture.

The first issue in the political series of the Bulletin of the University of Wisconsin is an examination of *The Geographical Distribution of the Vote of the Thirteen States on the Federal Constitution*, by *Orin G. Libby*. While State lines are used for convenience in pointing out the distribution of Federal and anti-Federal sentiment, attention is directed especially to those social and economic areas which have been the true units in political history. The monograph is accompanied by General Walker's map showing the distribution of the population of the United States in 1790, and a map showing the distribution of the vote on the Federal Constitution.

Parts II and III of Vol. XXVI, *Proceedings of the Boston Society of Natural History*, contain papers on Faceted Pebbles on Cape Cod, by Prof. W. M. Davis; Small Mammals from the New Hampshire Mountains, by Gerrit S. Miller, Jr.; Some Typical Eskers of Southern New England, by J. B. Woodworth; Spharagemon, a Study of the New England Species, by Albert P. Morse; Theories of Evolution, by Prof. Edward B. Poulton, of Oxford; and briefer communications from Profs. Harrison Allen, N. S. Shaler, F. W. Putnam, W. G. Farlow, and others. In the year 1893-'94 the society received by

gift a large number of stuffed animals from the Boston Museum collection. Some of these had been formerly in the famous Peale Museum in Philadelphia. The work of a guide in explaining the society's collections to visitors was continued through the year by the liberality of a Boston lady. An arrangement was made with the Boston Normal School whereby the resources of the society were employed to aid in the training of teachers of science. Other evidences of activity are reported.

The numbers of the *Journal of the College of Science, Imperial University, Japan*, as they come to us, bear continuous evidence of the original work that is done in scientific investigation by Japanese students. The latest three are Vol. VII, Part II, On the After Shocks of Earthquakes, by F. Ōmori, a careful study, with elaborate tables and sixteen plates and charts; Vol. VII, Part III, Mesozoic Plants from Kōzuke, Kii, Awa, and Tosa, by Matajiro Yokoyama, Professor of Paleontology, with ten plates; and Vol. VIII, Part I, Studies on the Ectoparasitic Trematodes of Japan, by Seitaro Gotō, of the Science College, with twenty-nine plates. The last two papers include full and definite descriptions of species.

A curious insight is given into the mythologies and modes of thought of some of our Indian tribes by the study of Mr. *J. Walter Fewkes* of *The Walpi Flute Observance*. This primitive drama, as we gather from Mr. Fewkes's concluding paragraphs, is performed on alternate years with the "snake" ceremonials, to celebrate the coming, in the early times, of the Horn or Flute people to Walpi, where the Bear people and the Snake people were living, and their reception by them. The ceremony illustrates the permanence and the significance of the mythologies and the rituals of primitive peoples, which are incomprehensible to our ordinary knowledge. The ritual is not to these peoples, Mr. Fewkes says, a series of meaningless acts, performed haphazard and without unity, varying in successive performances, but is fixed by immutably prescribed laws which allow only limited variations. Throughout the Flute ceremony there is the same rigid adherence to prescribed usages which exists in other rites, and there is the same precision year after year in the sequence of the various episodes. The observance is celebrated by a special fraternity, of which, as well as of the ceremonies, carefully detailed descriptions are given.

In *The World's Great Farm* (Macmillan & Co., New York) an attempt is made by *Selina Gay* to set forth and illustrate the economy of Nature. The world and all that is upon it are regarded as a vast farm, its tillers and its crops; and the purpose of the book is to tell what these crops are and how they are grown. First is the tilling, which is done by the pioneer laborers, the gases of air and water breaking up the rocks; the soil-makers —cryptogamic vegetation of lichens and mosses pulverizing the rock fragments and preparing them for the more dainty vegetation; soil-carriers—the winds and the waters; the field laborers—burrowing animals, from the earthworm up; the office of water as a factor in vegetable growth, the roots and the food drawing from the soil; leaves absorbing nourishment from the air; the blossom and seed and the various agencies employed in the fertilization of flowers, and to secure the scattering of the seed; the chances of life of the plant and the way they are guarded; the friends and foes of the Nature farmer and the militia by which the foes are kept down; and "Man's Work on the Farm"—the purpose being kept in view throughout, as Prof. G. S. Boulger says in the preface, to give an account which, while simple enough to be understood by unscientific readers, and so accurate as to teach nothing that will afterward have to be unlearned, shall also be extremely attractive in the selection and marshaling of facts.

A very favorable impression is made upon us by the *Popular Scientific Lectures* of Prof. *Ernst Mach*, of the University of Prague, of which a translation authorized, revised, and commended by the author, by Thomas J. McCormack, is published by the Open Court Publishing Company, Chicago. The lectures were delivered between 1864 and 1894, at Prague and Gratz, and were intended to give the public an intelligent comprehension of the nature of scientific work in the lines covered by them, and enlist their sympathy with it. The most of them are very lucid explanations of facts and phenomena concerning which the people are inquiring, while the last four are of a

more philosophical character, and deal principally with the nature and methods of scientific inquiry. The subjects are The Forms of Liquids, The Fibers of Corti, The Causes of Harmony, The Velocity of Light, Why has Man Two Eyes? Symmetry, The Fundamental Concepts of Electrostatics, The Principle of the Conservation of Energy, The Economical Nature of Physical Inquiry, Transformation and Adaptation in Scientific Thought, The Principle of Comparison in Physics, and Instruction in the Classics and the Mathematical Physical Sciences.

A discussion of much literary interest—and scientific, too, so far as it relates to the evolution, growth, and variations of popular tales—is given by Prof. *Richard Jones*, of Swarthmore College, in his book on *The Growth of the Idyls of the King* (J. B. Lippincott Company, Philadelphia). The effect of the study—especially of the Arthurian legends in their different versions—"is a disregard of the criticism that Lord Tennyson's ideal knight and blameless king is not the Arthur whom we know through Malory." Sir John Malory's Morte d'Arthur is a compilation from numerous legends in various languages. It does not form a consistent whole, and does not always present the most significant stories or the best versions. That Tennyson does not always agree with him means simply that he selected some other version than the one given by him, or exercised the poet's license of modifying the version to make it conform to his purpose. These views are brought out in the preliminary chapters of the book; and after this follows a minute criticism of the structure of Tennyson's group of poems, and a comparison of the editions from the earliest, showing by the successive changes in the text the gradual unfolding of his ideal.

The List of the Publications of the Bureau of Ethnology, compiled by *Frederick Webb Hodge*, with its index to authors and subjects, will be a valuable aid to students in this department. The Bureau has done most excellent work in a field where it was much needed, and at a time when it could be done more efficiently than ever afterward.

The *Index to St. Nicholas*, Vols. I to XXI, was composed by Mr. *W. M. Griswold*, an indexer well known by his other similar works, for the use of his children, aged eight and nine years. Any one who glances at it, the compiler says, "will see that few branches of knowledge suitable for children are unmentioned," while in some cases works are given which are models of what such should be.

In placing the book *Central Station Bookkeeping and Suggested Forms* before the electrical public, the author, *Horatio A. Foster*, has endeavored to show a classification of accounts and a system of reports for central light and power stations, such that the management may by their use know the full details of the business of distributing the electric current. It appears that the means of securing these data are very deficient, or neglected, at many of the smaller stations. The book contains diagrams for the organization of the staff of electrical central stations, the classification of accounts and reports, and includes sample forms for every department. It is devoted mainly to accounting departments of central stations, and outlines a scheme for their organization and routine which will enable the management to determine at any moment the condition of business and the unit cost of the generation and distribution of current. The forms were devised after an examination of several hundreds in practical use in many stations, and are intended to embody the best points of all. In an appendix is furnished a classification of accounts of electrical street railways, together with instructions, forms of books, etc., necessary to carry it out. (Published by the W. J. Johnston Company, limited, New York.)

The *Ninth Annual Report of the Commissioner of Labor, Carroll D. Wright*, relates entirely to Building and Loan Associations in the United States, including under that title all associations having the purpose indicated by it. Such associations have existed in this country since about 1840. Their growth has been very rapid since then, and their accumulated assets have increased to an enormous amount. As private corporations, doing a semi-banking business, conducted by men not trained as bankers, they offer a study in finance not afforded by any other institutions. England, France, and some other countries have kindred institutions, but nowhere have they grown to such vast proportions as in the United States.

Five thousand eight hundred and thirty-eight associations are represented, in the reports of which five thousand five hundred and ninety-eight were local and two hundred and forty national. The total dues paid in on installment shares in force, plus the profits on the same, amount to $450,667,594. "A business represented by this great sum, conducted quietly, with little or no advertising, and, as stated, without the experienced banker in charge, shows that the American people, in their own ways, are quite competent to take care of their savings." Only thirty-five of the associations now in existence showed a net loss at the end of their last fiscal year, and this loss amounted to only $23,332. When an association disbands, no loss can occur, because its whole business consists of loans, mostly to their own shareholders. A disbanded association, therefore, simply returns to its members their own property. Full particulars are given of the associations by States and by individual associations.

A History of Higher Education in Iowa has been prepared by Prof. *Leonard F. Parker*, of Iowa College, as Circular of Information No. 17 of the United States Bureau of Education. There is much in the educational history of Iowa, as Commissioner Harris well says, which is instructive to all students and observers of educational progress, since within the limits of that State a noteworthy zeal has prevailed from the time of the earliest settlements in founding institutions of learning and in providing instruction for all classes of people. The narrative tells the story of the first schools in Iowa previous to 1838, Education during the Territorial Period, Early Education in the State, the Free-School System, Provisions for the Education of Teachers, the State Agricultural College, the State University, Private Secondary Schools, Denominational Colleges, Institutions no longer existing, the Higher Education of Women in Iowa, and Educational Auxiliaries.

In the *Report on the Crustacea of the Order Stomatopoda* (No. XXXII of the Scientific Results of Explorations by the United States Fish Commission Steamer Albatross) Dr. *Robert P. Bigelow* makes a classification of the *Squilla* family from a study of the specimens in the National Museum, the Fish Commission, and a private collection made by him in the Bimini Islands (Bahamas). These, he finds, represent thirty-four species distributed through five genera, of which fourteen are new. The collection of larvæ was large, but unfortunately contained nothing like a complete series of stages of any one species. The changes of form between two stages are so great that almost no larva in the collection could be referred with certainty to its adult form.

In his paper on *The Systematic Position of the Siphonaptera* Prof. *Alpheus S. Packard* bases his opinions upon the work of Landois, Kraepelin, and Wagner, besides some work of his own. He believes that the fleas should be referred to an independent order, and not classed with the flies. He calls attention to the presence of a temporary larval structure in the dog flea (*Pulex canis*) that is, so far, unique among insects. This is an egg-shell burster. It is a thin vertical plate like the edge of a knife, situated on the median line, and so placed that the larva, by rubbing its head back and forth, would produce a slight split in the shell and cause it to burst asunder. In the larva just before hatching the plate is no more hard than the rest of the head; later it entirely disappears. While he places them nearer to the *Diptera* than to any other order, he calls attention to our very imperfect knowledge of their embryology, and states that the present assignment may be temporary.

From Volume XIII of the *Transactions of the New York Academy of Sciences* it appears that in the year ending in February, 1894, eighty-one papers had been presented before the academy. The departments of science most largely represented in these papers were zoölogy, astronomy, geology, and paleontology, in the order named. This volume contains the report of the committee on the Audubon monument, with the speech of Prof. Thomas Eggleston presenting the monument to the corporation of Trinity Church, that of Dr. Morgan Dix accepting it, and the address of Daniel G. Elliot on the life and services of Audubon. Among the more extended papers of the volume are Observations on the Geology and Botany of Martha's Vineyard, by Arthur Hollick; The Ore Deposits at Franklin Furnace and Ogdensburg, N. J., by J. F. Kemp; The Intrusive Rocks

near St. John, N. B., by W. D. Matthew; The Geology of Essex and Willsboro Townships, Essex County, N. Y.; and Microscopic Organisms in the Clays of New York State, by Heinrich Ries. Several are illustrated with plates or cuts. Appended to the volume is a catalogue of the articles shown at the first annual reception and exhibit of recent progress in science held by the academy, March 12, 1894.

The *Report of the Smithsonian Institution* for 1892–'93 is a record of work of the usual character done in the institution and its several allied bureaus—the United States National Museum, Bureau of Ethnology, National Zoological Park, and Astro-Physical Observatory. In accordance with the custom of several years past, the progress of science during the year of the report is represented by a considerable number of papers, mostly reprinted or translated from scientific journals, but some appearing first here. The subjects thus represented include photography in colors and photography of moving objects, aërial navigation, the ice age, polar exploration, American bows and arrows, descriptions of biological and meteorological stations, and a biographical sketch of Henry Milne-Edwards.

The operations carried on under the direction of the *United States Commissioner of Fish and Fisheries* in 1891–'92, as set forth in his *Report*, comprise inquiries into the causes of the decrease of food fishes in the waters of the United States, the collecting of statistics and accounts of methods of the fisheries, culture of fish at twenty-two stations and their distribution to the number of 228,000,000 fry, 75,000,000 eggs, and 2,000,000 adults and yearlings. Preparations for the extensive exhibit at the World's Columbian Exposition of the following year were carried on. Appended to the Report are several papers, the most considerable of which is on the Parasites of Fishes, by R. R. Gurley. Some Notes on the Oyster Industry of New Jersey are furnished by Ansley Hall, and there is a bibliography on oysters, by C. H. Stevenson.

The large and handsomely printed volume numbered two, which has been issued by the Iowa Geological Survey, is a full account of the *Coal Deposits of Iowa*, by *Charles R. Keyes*. After a general description of the carboniferous basin of the Mississippi Valley, the geology of the Iowa coal region is described in more detail, and the lithology and stratigraphy of the coal measures in this area are successively set forth. The coal beds now operated throughout the State are then taken up by counties, after which the composition and properties of Iowa coals are stated, and some information on waste in coal mining and the extent of the coal industry in the State is given. The volume is illustrated with many maps, views, and diagrams.

From the *Sixty-second Annual Report of the Perkins Institution*, of Boston, it appears that the total number of blind persons in the school, kindergarten, and workshop for adults, including sixteen employees, was 237 in September, 1893, an increase of twenty-seven during the preceding year. Music is so often a source of remunerative employment for the blind that this department receives special attention. There were three blind and deaf children—Edith Thomas, Willie Robin, and Tommy Stringer—in the school, and making more than satisfactory progress. Their portraits and special accounts of their school work are given. Ten or a dozen books were issued from the printing office in the course of the year. A second building for the kindergarten had been completed, and the number of pupils in that department had increased to sixty-four.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Reports and Bulletins. Connecticut: Eighteenth Annual Report. Parts II, III, and IV. Pp. 224.—Cornell University: Peach Yellows. B. L. H. Bailey. Pp. 20.—Massachusetts: Nos. 54, 55, and 57. Meteorological Summaries and Analyses of Food, Fodder, and Manures. Pp. 8, each.—New Jersey: Fungous Diseases of Beets. By B. D. Halsted. Pp. 13.—Field Experiments with Fungicides. By B. D. Halsted and J. A. Kelsey. Pp. 32.—New York: No. 82, Manufacture of Cheese. Pp. 64. No. 83. Insects and Insecticides. Pp. 32. No. 84. Spraying Pear and Apple Orchards. Pp. 36. No. 85. Analyses of Commercial Fertilizers. Pp. 28.—North Dakota: Meteorological Summary, February. Pp. 13.—Ohio: No. 53. The Russian Thistle. Pp. 16, with Plates.—The San José Scale. Pp. 16, with Plate.—University of Illinois: No. 34. Experiments with Wheat and Oats. Pp. 24. No. 35. The Russian Thistle. Pp. 4. No. 37. Corn Experiments. Pp. 24.

Alvarez, Antonio M., Director. Revista Potosina (weekly). San Luis Potosí, Mexico: José Guerra. Pp. 8.

American Forestry Association. Proceedings, Vol. X. Pp. 93–140.

American Society of Naturalists. Records. Vol. I, Part XIV. Boston. Pp. 32.

Balch, Thomas Willing. Some Facts about Alsace and Lorraine. Philadelphia: Geographical Club (Bulletin). Pp. 16.

Bardeen, Charles Russell. Infection and Immunity. Syracuse, N. Y.: C. W. Bardeen. Pp. 20.

Benedict, A. L. Tabular Review of Organography for Classes in Botany. University of Buffalo.

Boas, Franz. Salishan Texts. Pp. 18.

Boiler Review. Monthly. Vol. I, No. 4. Middletown, N. Y.: Hogan Boiler Company. Pp. 64.

Brooks, Noah. How the Republic is Governed. New York: Charles Scribner's Sons. Pp. 169. 75 cents.

Call, H. L. The Coming Revolution. Boston: Arena Publishing Co. Pp. 239.

Calvin, Samuel, State Geologist, and Assistants. Iowa Geological Survey, Vol. III. Second Annual Report, 1893, etc. Des Moines.

Cambridge Natural History, Vol. III. Mollusca, by A. H. Cooke; Brachiopods (Recent), by A. E. Shipley; Brachiopods (Fossil), by F. R. C. Reed. Macmillan & Co. Pp. 535. $2.60.

Carter, Oscar C. S. Drilling for Oil and Natural Gas in the City of Philadelphia. Pp. 7.

Clodd, Edward. A Primer of Evolution. New York: Longmans, Green & Co. Pp. 186.

Collie, George L., Beloit College. The Geology of Conanicut Island, R. I. Pp. 32.

Comstock, John Henry, and Anna Botsford. A Manual for the Study of Insects. Ithaca, N. Y.: Comstock Publishing Co. Pp. 701. $3.75 net, $4.09 postpaid.

Conn, H. W., Middletown, Conn. Bacteria in the Dairy. Pp. 36.

Conway, Moncure D., Editor. The Writings of Thomas Paine, Vol. III, 1791–1804. New York: G. P. Putnam's Sons. Pp. 435.

Cope, E. D. New and Little Known Paleozoic and Mesozoic Fishes. Philadelphia: Academy of Natural Sciences. Pp. 116.

Cornell University. Courses of Instruction in the President White School of History and Political Science. Pp. 29.

Cox, Rowland. The Constitution of the United States and its Relation to the Subject of Trade Marks. Pp. 30.

Cressey, G. C. The Essential Man. Boston: G. H. Ellis. Pp. 89. 75 cents.

De Gubernatis, A. La Vita Italiana (Italian Life). Illustrated Tri-monthly. Rome, Vol. I, Nos. 1 and 2. Pp. 128. 25 lire a year.

Defoe, Daniel. History of the Plague in London. American Book Company. Pp. 253. 40 cents.

Duggan, Thomas J. Old Glory. A Prize Patriotic Song for Mixed Voices. Music by Homer N. Bartlett. Philadelphia: Henry Coleman. 10 cents.

Foote, Allen Ripley. A Sound Currency and Banking System: How it may be Secured. New York: G. P. Putnam's Sons. Pp. 110. 75 cents.

Gilbert, G. K. Sedimentary Measurement of Cretaceous Time. University of Chicago. Pp. 7. —Results of a Transcontinental Series of Gravity Measurements. Philosophical Society of Washington. Pp. 44.

Gilbert, G. K., and Gulliver, F. P. Tepee Buttes. Rochester, N. Y.: Geological Society of America. Pp. 10.

Green, Mary E. Condiments, Spices, and Flavors. Chicago: The Hotel World. Pp. 44.

Greenwood, Frederick. Imagination in Dreams, and their Study. New York: Macmillan & Co. Pp. 198. $1.75.

Harrington, Mark W. Central American Rainfall. Washington: Philosophical Society. Pp. 30, with Plates.—Surface Currents of the Great Lakes. United States Department of Agriculture. Six Charts and eight pages letterpress.

Harris, William T., Commissioner. Report of the Commissioner of Education for 1891–'92. Washington: Government Printing Office. Two vols. Pp. 1294.

Heilprin, Prof. Angelo. The Progress of Discovery, etc.; also Peary, Robert E. Preliminary Report on the Arctic Expedition of 1893–'94. Philadelphia: Geographical Club. Pp. 40.

Hodge, F. W. The First Discovered City of Cibola. Washington: Judd & Detweiler. Pp. 11.

Iowa, State University of. Narrative and Preliminary Report of Bahama Expedition. By C. C. Nulling. Pp. 252.

Jaccard, A. Le Pétrole, l'Asphalte, et le Bitume, au Point de Vu Géologique (Petroleum, Asphalt, and Bitumen from the Geological Point of View). Paris: Felix Alcan. 6 francs.

Konvalinka, J. C. The Cold Waves: How to Stop Them, etc. Pp. 4.

Kelly, Edmond. Evolution and Effort, and their Relation to Religion and Politics. New York: D. Appleton & Co. Pp. 297. $1.25.

Larned, W. C. Churches and Castles of Mediæval France. New York: Charles Scribner's Sons. Pp. 236. $1.50.

Long, C. C. Home Geography for Primary Grades. American Book Company. Pp. 141. 25 cents.

Magee, W. H. Indexes of the Literatures of Cerium and Lanthanum. Smithsonian Institution. Pp. 43.

Martha's Vineyard Summer Institute. Eighteenth Annual Session. July 8, 1895. Pp. 46.

Mason, Otis Tufton. Similarities in Culture. Washington. Pp. 16.

Massachusetts Agricultural College. Thirty-second Annual Report. Boston. Pp. 152.

Merrill, George P. Disintegration of the Granitic Rocks of the District of Columbia. Rochester, N. Y.: Geological Society of America. Pp. 12.

Michigan Mining School. Catalogue and Announcements. Houghton, Mich.

Minot, H. D. The Land Birds and Game Birds of New England, etc. Houghton, Mifflin & Co. Pp. 492. $3.

Morse, Lyman D., New York. The Advertiser's Handy Guide for 1895. Pp. 783.

Moses, A. J., and Parsons, C. L. Elements of Mineralogy, Crystallography, and Blowpipe Analysis from a Practical Standpoint. New York: D. Van Nostrand & Co. Pp. 342.

New York. State Board of Charities. Annual Report for 1894. Albany. Pp. 576.

Phenix, G. P. First Lessons in Chemistry. Boston: D. C. Heath & Co. Pp. 41. 20 cents.

Pickering, W. H. Investigations in Astronomical Photography. Pp. 115. Observatory of Harvard College.

Powell, John W. Physiographic Features. American Book Company. Pp. 32.

Quantin, A., Paris. Le Monde Moderne. Illustrated Monthly, Vol. I, No. 1. Pp. 138. 21 francs a year.

Richards, Joseph W. The Suitability of Aluminum for Minor Coins. New York: The Aluminum World. Pp. 5.

Robertson, Charles. The Philosophy of Flower Seasons, etc. Pp. 20.—Flowers and Insects. Two papers. Pp. 48 and 10.

Rockwood, Frank Ernest, Editor. Cicero's Cato Major de Senectute. American Book Company. Pp. 159.

Society for Psychical Research. Proceedings, March, 1895. London. Pp. 172.

Spencer, Mr. Herbert, on the Land Question. New York: D. Appleton & Co. Pp. 30.

Sterling Publishing Company, New York. A New Plan of Relief by Work. Report on Agricultural Commission. Pp. 7.

Stockbridge, Horace Edward. Rocks and Soils; their Origin, Composition, and Characteristics New York: John Wiley & Sons. Pp. 282.

Thomson, William, M. D., Philadelphia. The Practical Examination of Railway Employees. Pp. 18.—A New Wool Test for the Detection of Color Blindness. Pp. 11.

Vermeule, C. C. Geological Survey of New Jersey; Report on Water Supply, etc. Trenton. Pp. 96, with Maps and Plates.

Vincent, Frank. Actual Africa; or, The Coming Continent. New York: D. Appleton & Co. Pp. 541. $5.

Wahl, W. H. The Franklin Institute. A Sketch of its Organization and History. Published by the Institute, Philadelphia. Pp. 103.

Webster, Daniel. The Oration on Bunker Hill Monument, the Character of Washington, and the Landing at Plymouth. American Book Company. Pp. 101. 20 cents.

Wiley, Harvey W. Principles and Practice of Agricultural Analysis. Easton, Pa.: Chemical Publishing Company. Vol. I, Soils. Pp. 607.—The Synthetic Food of the Future. Pp. 21.

Winchell, N. H., State Geologist. The Geology of Minnesota, Vol. III, Part I, of the Final Report. Minneapolis. Pp. 540, with 41 Plates.

Wright, Carroll D., United States Commissioner of Labor. The Slums of Baltimore, Chicago, New York, and Philadelphia. Washington: Government Printing Office. Pp. 620.

Wright, G. F. Glacial Phenomena of Newfoundland, Labrador, and South Greenland. Pp. 8.

POPULAR MISCELLANY.

Death of Professor Dana.—Prof. James Dwight Dana, the veteran American geologist, died at his home in New Haven, Conn., of disease of the heart, April 14. He had been apparently in good health, manifesting no signs of weakness other than by taking his walks less frequently, but on the morning before his death was attacked with a nervous fluttering of the heart, which, being not uncommon with him, was not regarded as serious. After sleeping for a while at night, he awoke feeling worse, and died before the doctor was able to reach him. A brief sketch of Prof. Dana's life and work up to that time was given in the third number of The Popular Science Monthly, July, 1872. Besides the books and published papers mentioned in that article he has since revised the text-books and manuals of geology and mineralogy, bringing them up to very recent dates; added to his works The Geological Story Briefly Told and a small volume on the New Haven region entitled The Four Rocks; contributed numerous papers on scientific subjects to the journals in which they appropriately found a place; and edited the American Journal of Science to the end of his life. He continued to serve in his professorship in Yale College till 1892, when he asked the corporation to appoint his successor, and Prof. H. S. Williams was elected; but he continued, at the request of the corporation, to deliver his lectures till January, 1894. After this he finished the revision of his Manual of Geology, which has been published recently; continued his contributions to the American Journal of Science; kept up his investigation of the phenomena of the Hawaiian volcanoes, for which he made a recent visit to the Sandwich Islands in 1887; and completed a short work on Cephalization, or a system of classification based upon progressive nerve centering in the brain. He was a man of lovable disposition and high personal character; and he held honors, memberships, or medals from most of the important scientific societies of the world. The complete list of his books and published papers given in the American Journal of Science contains two hundred and fourteen titles. It begins with a paper on the Condition of Vesuvius in 1834, published in 1835, and ends with the fourth and revised edition of the Manual of Geology, which Prof. Dana finished in February, 1895. A month later he had completed the manuscript of a new edition of The Geological Story, and then began work on a new edition of the Text-Book.

Treatment of the Morally Defective.—The question of the treatment proper to be applied to the morally defective was treated with considerable effectiveness by Prof. A. J. McClatchie, in a lecture delivered at Pasadena, Cal. The speaker first named the influences under which persons became criminals. Many are born of convicts or of criminals who have escaped punishment, and hence have a natural tendency to be morally deranged. Other persons are surrounded by unfavorable circumstances, and, being weak, are drawn into a life of crime against their will. Others are quick-tempered, irritable, supersensitive, and liable at any time to be provoked to do that which they would not do in soberer moments. Others are born of good parents and have good surroundings, but under certain circumstances—such as the influence of bad associates—and in their weakness yield gradually to temptation, and thus slowly develop into criminals. Shutting these per-

sons in prisons with more hardened criminals, where all the influences are demoralizing and not one healthful—the ordinary course—is obviously not the best one or a good one in any way. Prof. McClatchie, on the other hand, looking upon the cases as involving moral disease, outlines a reformatory treatment based on principles similar to those which rule at the Elmira institution. The first precept to be observed in it is that first offenses should never be overlooked; vigorous treatment in the beginning is really a kindness to the subjects. Next, a system of graded institutions is needed, so that prisoners may be classified and segregated. "Those guilty of different degrees of criminality should be placed in different institutions and given entirely different treatment. The sentence should in all cases be what is called indeterminate—that is, no one should be sentenced for any given time. He should be placed in the institution and should remain there until competent men pronounce him cured. The treatment should all be disciplinary. It should not consist of simply kind treatment, but should be firm and vigorous. All three of their natures—their physical, mental, and moral—must be treated simultaneously." The discipline must be continued until it is easy for the subjects to control their will and to use their hands and their minds in the right manner. "They must form the habit of doing right until it has become a part of their nature, or the work will not be thoroughly done. . . . If it is found that it is impossible to reform the criminal, he should be kept confined indefinitely."

St. Augustine and the Days of Creation.—St. Augustine of Hippo is said to have been a diligent student of the Mosaic record of the creation, and tried earnestly to find a method of interpreting it consonant with what he knew of the facts of Nature. In writing of this feature of his career the Rev. John A. Zahm, of the University of Notre Dame, says that during the twenty-five best years of his life the first two chapters of Genesis were continually before his mind. What did Moses mean by the word "days"? he asked again and again. "How could there be days in the ordinary acceptation of the word before the sun was created on the fourth day? Were not the first three days mentioned by Moses periods of time rather than ordinary days of twenty-four hours each? And what about the seventh day—a day that had no evening—a day, therefore, that still endures? How explain, according to the laws of Nature, which are the laws of God, the production and development of the various forms of plant and animal life in the short period of six ordinary days? The idea that God, during the days of Genesis, operated in a manner different from that which subsequently characterized his providence, that the laws which governed the material universe were not the same then that they were afterward; that the Hexaëmeron was distinguished by a series of miracles and a succession of specific creations rather than by the reign of law that the Creator himself had imposed on matter, and by which it was endowed with the power of gradual evolution and differentiation, seemed so repugnant to the keen and logical intellect of Augustine that he could never bring himself to adopt it, much less give it his support. . . . The word 'days,' according to the illustrious doctor, was not to be taken in a literal but in a figurative sense. They meant not ordinary days, but the works of creation which were unfolded in time by a series of progressive transformations. For a similar reason the words 'evening' and 'morning' are to be interpreted metaphorically as meaning not dusk and dawn, but the beginning and end of the divine works. God, according to St. Augustine, as well as according to St. Gregory of Nyssa, first created matter in an elementary or nebulous state. From this primordial matter — created *ex nihilo* (from nothing) — was evolved, by the action of physical laws impressed on it by the Creator, all the various forms of terrestrial life that subsequently appeared. In this process of evolution there was a succession, but no division of time. The Almighty completed the work he had begun, not intermittently and by a series of special creations, but through the agency of special causes, by the operation of natural laws—*causas rationes*—of which he was the author."

Wabbling of the Earth.—Displacements of the rotational axis of the earth, says Prof. Forster in a paper read in the British Asso-

ciation, have been observed from the very earliest times, and are so great that they can be detected with very simple apparatus. These effects are due to exterior causes, and consist in a displacement of the axis of the earth in space, and a consequent wandering of the pole among the stars. The action of internal forces in the earth would be to produce a displacement in the rotating body itself. A deviation of the rotational axis from the principal axis of inertia would cause a rotation of the pole round the principal axis of inertia. Such a rotation would have a period of nearly ten months, and could be best detected by continuous and active observations of latitude at various observatories. Measurements were made as early as the middle of this century, but gave no definite results, the ten-monthly period being marked by other disturbances due to currents and circulations in the atmosphere, oceans, and rivers. Four years ago the International Geodetic Union secured co-operation of observations, and this, together with an expedition to Honolulu, has led to definite results. These show that the north pole wanders through about fifty feet between its extreme positions.

Bactericidal Solar Rays.—Although investigation has not been idle, experimenters have not been wholly agreed as to the exact property or field of the sun's rays which is most efficient in action on bacteria and fungi. The inquiry has been continued by Prof. H. Marshall Ward, to whom the thought occurred in the course of his work that the most direct answer to the question, Which rays are the most effective ones? might be best obtained by shining the solar spectrum directly upon the film of spores, and making it record the effects by their subsequent behavior, according as the different groups of rays fell upon them—in other words, by obtaining a photograph of the spectrum in living and dead bacteria. The results showed conclusively that the rays that kill the bacteria are the blue and violet ones. An observation was made during the investigation which may go far to account for the unsatisfactory character of the determinations of former experiments. The chief difficulty to be overcome was the great weakening of the intensity of the dispersed rays of the beam of light decomposed to form the spectrum—a weakening caused by the distribution of the incidence of the rays over a larger area and by their absorption and reflection in passing through the lenses and prisms. It was found also, in working with the electric light, that the power of the blue and violet rays was further impaired—in other words, that they were stopped—by the material (glass) through which they had to pass. The effect of the glass was practically the same as that of mist or haze in the atmosphere, which so filters out the blue-violet rays that the light of a dull day was of little effect in the author's experiments. These difficulties were overcome by using quartz instead of glass, with which it was possible to obtain a very pure spectrum sufficiently rich in blue and violet rays to kill the spores in a few hours. The author found it easy to obtain satisfactory results in the summer with the solar rays, even with glass lenses, mirrors, etc., and exposures of five or six hours, but in winter the exposures required to be so long as to be almost impracticable.

Work of the Peabody Museum.—The Curator of the Peabody Museum of American Archæology and Ethnology calls attention, in his report for 1893–'94, to the lack of room in the museum. Several collections made under the curator's direction have been secured. Besides a generous gift of money, Mr. Clarence B. Moore has contributed a good representative collection of the singular pottery which he obtained from a mound in Florida, and other objects of interest from the burial and shell mounds of that State. The publication of Mr. Nuttall's memoir has been provided for, and the work has been held in press for the incorporation of newly discovered facts. Space has been provided for the collections of archæological, historical, and educational objects and relics made by the late Mrs. Hemenway, of which Mr. J. Walter Fewkes is in charge. The collection of Mr. Frederick H. Rindge, deposited in the museum, contains the finest and most extensive lot of obsidian implements ever brought together from the Klamath country. Some of the chipped implements are remarkable for their size, and others for their beautiful finish. The collection also includes gems of workmanship in stone, bone, and ivory

from the tribes of the northwest, and many carvings obtained from the Eskimos. Dr. C. C. Abbott has presented a quantity of material obtained from the site of an old Dutch trading house on the Delaware, which tells the story of the early contact of the white race with the Indians. Mr. Valk explored during the year an ancient village site and burial place in the Delaware Valley, where interesting discoveries were made relating to the early inhabitants. In his examination of the singular and ancient burial places on the coast of Maine, Mr. Willoughby has ascertained several important facts, and has obtained many interesting objects, some of which show Eskimo affinities. Mr. George Byron Gordon has undertaken the exploration of Copan under a concession from the Government of Honduras. More money is needed for this work, and other institutions are invited to cooperate in it. The collection already in the museum is pronounced to be of remarkable interest and not equaled elsewhere, but is so crowded and unprotected that it is not open except under special arrangement. The course of general anthropology was attended by nine pupils.

The Passing of Torture.—Asiatic peoples tolerate torture, practice it, almost seem to like it (the infliction of it, that is); European nations do not now permit it. The difference presents a problem in the development of human character. Europeans did not always abhor torture; they have changed since the Romans delighted in gladiatorial shows and in seeing captives and Christians thrown into the arena to be devoured by wild beasts. Aversion to torture can hardly be called a characteristic of Christians, although it is inculcated in the Christian code, and may have been developed under Christian teachings. King Menelek of Abyssinia, who is said to have recently condemned a treacherous page to terrible sufferings by mutilations and exposure in the wilderness, calls himself a Christian. The Inquisition was in full blast under the ægis of the Church only two or three centuries ago, and *autos da fé* were festivals in Madrid down to 1750. Prisoners convicted of certain crimes were broken on the wheel only a bare hundred years ago in France. Torture was legal in Denmark within living men's memories, and is still practiced, though not authorized, in Russian prisons. And what are we to say to the punishments still sometimes inflicted upon offending negroes in the southwest? But these things have passed away, and only a few vestiges of them, like the last mentioned, remain among any men of European lineage, while the world at large abhors the recital of them. Having shown a number of other special causes the validity of which, he considers, can not be depended upon to account wholly for the change, a writer in the London Spectator assumes that "there must be some separate moral impulse which has arisen apart, or in a certain degree apart, from any teaching of the creeds; and we find it difficult not to believe that it is a new impulse, that man's moral nature has on this side made in Europe a distinct stride forward. It is an advance the extent and depth of which have not yet been tested, for the masses of Europe have not of late years been provoked to furious anger, as they once were, by heresies and treasons, or as they may be, by and by, by anarchist explosions; but it is an advance which it is impossible not to recognize, and one that has gone far down, reaching classes whom the spirit of practical Christianity has hardly touched. If that is true, it is the most hopeful thought suggested by any of the social phenomena around us; and after much observation, continued for many years, the present writer can hardly doubt that it is true."

Oysters and Disease.—In view of what has been said of the possibility of the communication of disease by eating raw oysters, inquiries have been instituted by the English Local Government Board into the circumstances under which the cultivation and storage of shellfish along the coast are carried on. As a result of his bacteriological investigation of water from an oyster bed and of oysters from the same source, Prof. Cruikshank, of King's College, London, reports that he found a considerable number of bacteria in the sea water, but very few in the liquid of the oyster, in which the increase of bacteria was also very slow, but that in both cases the bacteria were familiar and harmless species, and there was no septic odor. Hence he finds no evidence that would lead him to condemn the oysters as

dangerous or unfit for food. Nevertheless, he adds, the possibility of a constant or intermittent contamination of the oyster beds ought to be carefully inquired into.

American Women in Science.—The annual meeting of the National Science Club for Women was held in Washington, January 2d, 3d, and 4th, in the new reading room of the club in the Lenman Building. The election of officers resulted in the choice of Mrs. Rosa Smith Eigenmann, of Bloomington, Ind., as president; Mrs. Almena B. Williams as vice-president; Miss Isabel Lenman as treasurer; Mrs. Laura Osborn Talbot as general secretary; Mrs. Edward Goodfellow as recording secretary, and Mrs. Horatio King, Mrs. Mark Harrington, Mrs. Herschell Main, Mrs. Anna Lowell Woodberry, all of Washington, and Mrs. Jean Brooks Greenleaf, of Rochester, N. Y., as members of the Executive Committee. The address of the retiring president, Mrs. A. D. Davidson, who had served for three successive terms, was mainly upon geological forces in Europe. General meetings were held on Thursday, January 3d, at the Hall of the National Museum, where a lecture was delivered by Mrs. Olive Thorne Miller on The Birds our Brothers, and papers were read constituting a rich programme of scientific essays by members from all parts of the country. On Friday, the 4th, the Council met at the Lenman Science Rooms, and adjourned till January, 1896. These rooms will henceforth be open to women who come to Washington for scientific study and investigation, who will be admitted on cards from members. The library needs gifts of books and pamphlets in science.

The Koreans.—While the Koreans generally display Mongolian characteristics, features are often met with in them almost European in refinement and Caucasian in cast, indicating a mixture of race among them. As described by Mr. H. S. Saunderson, they are tall, finely built, with features approaching more nearly to the European cast of countenance than those of the Chinese or Japanese. Their hair is black, sometimes shading to brown; is worn by the men tied up into upright columns on the tops of their heads, and by the women parted in the middle and made into chignons. Both sexes have small hands, which they are careful to keep clean and soft, and small feet. Their complexions are not so dark as those of the Chinese, nor so yellow. Their foreheads are high, and their voices are low and well modulated. They are genial when treated according to their notion, ready to laugh at a good joke, and to throw themselves into the fun of the moment. They are very proud, but treat foreigners politely while they despise them. Their policy of isolation is the result of long and hard wars with the Chinese and Japanese, and was adopted in the first place to make the country difficult of access to hostile forces. According to Mr. Saunderson, its effects have been detrimental to the national character. Their dress is strictly regulated. They pay great attention to the cleanliness of their outer robes. "No one who respects himself will ever appear in a dirty coat. Consequently, the women's chief occupation consists of washing the raiment of their lords and masters, and far into the night can be heard the tapping of the sticks with which the wet clothes are beaten—a most destructive process. As the clothes are but roughly tacked together and are glued at the seams with rice paste, they come to pieces every time they are washed, and have to be reglued when dry. The starch used consists of a mixture of rice paste and honey, and it gives the surface a peculiarly beautiful gloss." This regard for cleanliness does not extend to the underclothing or the body, which, according to Mr. Saunderson, are shamefully neglected. In summer basket-work frames are worn on the arms, back, and chest, under the robes, in order to keep the latter clean and dry, and also for the sake of coolness.

The Pamirs.—The term Pamirs, as applied to a particular region in central Asia, was defined by the Hon. George Curzon in a recent address before the Royal Geographical Society. It does not mean a vast tableland, as some suppose, or a "series of bare and storm-swept downs," as others have conceived, or a steppe; but, as is illustrated in the region itself, a mountainous valley of glacial formation, differing from the adjacent or other mountain valleys only in its superior altitude and in the greater degree to which

its trough has been filled up by glacial detritus and alluvium. It thereby approximates in appearance to a plain. This appearance is due to the inability of the central stream to scour for itself a central channel—a fact attributable to the width of the valleys and the consequent absence of glaciers on any scale, and to the short summers, which do not last long enough, or receive sufficient solar heat, to admit of a very powerful erosive impetus being communicated to the melting snows. Mr. Curzon estimates the extreme length and breadth of the Pamirs to be nearly equal, and each about one hundred and fifty miles.

A Model Public Library.—The report of the Board of Directors of the Los Angeles Public Library, Cal., furnishes many facts of much interest. One of the most noteworthy of them is the declaration that the library has been a paying investment for the city, as a means of education and recreation to the citizens, and as an attraction to the tourist population. Among the novel features is that of the circulation of current literature, which has met with hearty appreciation from the beginning, and is believed to have been a potent feature in encouraging the reading of the best class of the books and periodicals of the time. Another popular feature is the musical department, which has been much utilized by students of music, and has proved a means of education. Early in the administration of the library, civil-service rules were adopted for the appointment and regulation of the staff of attendants. The first appointments were made after a rigorous examination into the qualifications of applicants, ignoring all objects except the greatest good of the library. A training class was established in November, 1891, from the graduates of which, and of succeeding classes, all appointments to the staff have since been made. Appointments and promotions are all regulated according to efficiency and length of service; and it being understood that the employed of the library are entitled to retain their positions during good behavior, the formality of reappointment from year to year has not been recognized as necessary or advisable. It shows how little the American people are removed from barbarism in the management of public affairs that these matters—embodying the plainest and most obvious common-sense principles—have to be explained in the report and shown to be right. The library has 42,313 volumes; gave out for reading at home or in the library or the reference room, 489,086 volumes in 1894; has 18,057 registered members; and employs nineteen attendants.

The Office of Natural Selection.—Natural selection, Prof. A. S. Packard holds, in his paper on the Inheritance of Acquired Characters, as he has from the first insisted, is not an initial or impelling cause in the origination of new species and genera. It does not start the ball in motion; it only, as we might say, guides its motions down this or that incline. It is the expression, like that of "survival of the fittest" of Herbert Spencer, of the results of the combined operation of the more fundamental factors. In certain cases we can not see any room for its action; in some others we can not at present explain the origin of species in any other way. Its action increased in proportion as the world became more and more crowded with diverse forms, and when the struggle for existence had become more interesting and intense. It certainly can not account for the origination of the different branches, classes, or orders of organized beings. It in the main simply corresponds to artificial selection; in the latter case man selects forms already produced by domestication, the latter affording species and varieties due to change in the surroundings—that is, of soil, climate, food, and other physical features, as well as education.

An Ancient Flint-Implement Factory.—Large numbers of flaked stone implements of beautiful form and material, and in some cases of unusual size, are abundant in the Mississippi Valley within a radius of one hundred and fifty miles of St. Louis. An important site, from which a material and instruments were supplied closely corresponding with those used in the St. Louis region, has been found nearly three hundred miles southwest of that city, and is described by Mr. W. H. Holmes. The stone is a whitish or light-gray chert, of conchoidal fracture, flaking easily, and resonant. The excavations are in three groups, occupying four or

five acres, and are roundish pits and trenches. "The story of the working of the quarry and the management and the manipulation of the stone is to be read with almost as much ease as if the work had closed but yesterday. The fragments and masses of fresh chert were selected and removed from the pits, and the work of reduction and manufacture began. Shops were established on the margins of the pits, on the dump heaps, and at convenient points in the vicinity. . . . The shops are very numerous over the level space included between the three main groups of quarries, but, as a rule, they are not found more than one hundred or one hundred and fifty feet from the pits. Small trimming shops are found, however, much farther away, scattered through the forest and along the water courses." The circular clusters of white chert refuse are clearly defined on the dark ground, and especially so after forest fires have destroyed the growth of weeds and small underbrush. In the center is a shallow depression, which was the fireplace of the lodge. Around this the workmen sat, and here are the fragments and flakes, the rejects and hammer stones left by them, covering about the space inclosed by the lodge, and hardly disturbed since the site was deserted. Where the work has gone on for a long time, near the quarry margins the accumulations of refuse are so great that separate shops are obliterated, a number coalescing in the general mass, which in some cases reaches many feet in depth. One can sit on these accumulations and, without changing position, select bushels of the abortive implements and partially worked pieces broken under the hammer. Little or no specialization of form was attempted on the quarry sites; but blanks were chiefly made to be subsequently elaborated. It is evident that all the work was professional.

The Eight-hour System in Practice.—A most successful result of the operation of the eight-hour system is recorded in the works of Brunner, Mond & Co., English manufacturers. It has been in force there for five years, and the result has not been an increase in the cost of production. At first the wage cost per ton went up, but it then dropped, and is now as low as it was in 1889, the last year of the twelve-hour day. The managers are satisfied that the result is not owing wholly to improvements in machinery or methods of manufacture, but largely to the change in the length of the working day. They affirm that though the men work fewer hours, the efficiency of their work is not diminished, and their opinion is borne out by the fact of such improvements as greater regularity in attendance, increased application, and better health among the employed. The men used often to be irregular and drunken; now they come to their shifts regularly and sober. They are no longer found asleep at their posts. "The improvement in the men's looks," Mr. Brunner says, "and especially in their gait when leaving the works at the end of the shift, is very marked."

Astronomical Work of Harvard Observatory.—The forty-ninth annual report of the Director of the Astronomical Observatory of Harvard College is for the eleven months ending September 30, 1894. The most important events of the year were the practical trial of the Bruce telescope and the successful operation for several months of the Boyden Meteorological station on the summit of the Misti (Peru), at a height of 19,200 feet. Some criticisms that have been made of the photometric work of the observatory are answered, so far as they are of a scientific character. Sixteen hundred and fifty-seven photographs were taken with the eight-inch Draper telescope, and seventeen hundred and eight in Peru with the eight-inch Bache telescope. Seven variable stars were shown to have the hydrogen lines bright in their photographic spectra. Eleven new variables were discovered from the presence of bright hydrogen lines in their spectra, besides three whose variability was discovered from changes in their photographic images. Five gaseous nebulæ were discovered from their spectra. Several photographs were obtained of the new star in the constellation Norma, the spectrum of which, as in the case of the new star in Auriga, has become that of a gaseous nebula. This object is gradually becoming fainter. Nine hundred and twelve photographs were taken with the eleven-inch Draper telescope. An investigation has been in progress for the detection of stars having large parallaxes or proper motions.

The meteorological station on the Misti was successfully conducted for several months, one of the assistants visiting it every ten days and readjusting the self-recording instruments, till the station was broken into by Indians and some of the instruments were carried off. Long-exposure photographs were taken at Arequipa of three nebulæ and clusters under an improved method by which certain errors due to flexure and refraction are corrected. The great advantages of the atmospheric conditions at Arequipa are insisted upon. With the Bruce photographic telescope the spectra of the faint stars prove very satisfactory; and stars too faint to be photographed with other instruments can thus be studied. Experiments have been made to determine the photographic magnitudes of the brighter stars on a uniform scale.

The New Element in the Atmosphere, Argon.—The real existence of the new element which Lord Rayleigh and Prof. Ramsay claim to have discovered in the atmosphere appears to be proved by further investigations, of which, and of the substance itself—named *argon*—the discoverers recently gave a full account at the University of London before the members of the Royal Society. The discovery seems to have been first made by Lord Rayleigh in the course of his experiments for the determination of the densities of some of the more permanent gases. He found that nitrogen obtained from chemical compounds was about a half per cent lighter than when obtained from the atmosphere. Prof. Ramsay took up the investigation with Lord Rayleigh's permission. Both achieved the separation of argon from nitrogen; Prof. Ramsay by a chemical method, and Lord Rayleigh by the process of "sparking." It has now been separated from the air by atmolysis—a kind of filtering process applied to gases—by red-hot magnesium, and by sparking. Its density has been determined to be about 19·7. It is very soluble in water, and it has been proved that the nitrogen extracted from rain-water is twice as rich in argon as that which exists in the air. Argon is best obtained by freeing the air, from which carbonic acid and water have been removed, from oxygen by means of red-hot copper and then absorbing the nitrogen by means of metallic magnesium, which, when heated to redness, combines with the nitrogen, forming an orange-colored mass of magnesium nitride. The residual gas after this series of operations—the passage of the gases being repeated again and again—is argon. In this process chemically derived nitrogen yields no such residue. The density of pure argon is 20 (19·7); hence its molecular weight, in accordance with Avogadro's law, must be 40. There are reasons for believing that, like mercury, its molecule contains but one atom; its atomic weight, 40, is therefore identical with its molecular weight. Argon is soluble to the extent of four volumes per one hundred volumes of water, so that it is about two and a half times as soluble as nitrogen, and possesses approximately the same degree of solubility as oxygen, and is accordingly found to occur in increased proportion to nitrogen in rain-water. According to Dr. Olszewski, argon easily condenses to a colorless liquid at a temperature of −128·6° C. and under a pressure of thirty-eight atmospheres. At a lower temperature argon freezes to a crystalline mass like ice; at a still lower temperature it becomes white and opaque. Its freezing point is −189·6°, its boiling point −187°, and its density as a liquid is 1·5. Mr. Crookes has found that it has two spectra, marked by red and blue lines respectively. This indicates that it may be a mixture of two elements. Other properties indicate that it is a single element, and the weight of the evidence seems so far to be in favor of this supposition. There are difficulties in the way of the unqualified acceptance of either view. It presents other problems of constitution and behavior, in view of which much study will yet be required before a satisfactory conception can be gained of its exact nature and of its place in the chemical series. It is chemically the most inert element yet found.

Distinction of Animals and Plants.—Finding that the definitions of the distinctions between animals and plants fail when the attempt is made to apply them to the lower organisms, Prof. Charles S. Minot suggests, in Science: "Animals are organisms which take part of their food in the form of concrete particles, which are lodged in the cell protoplasm by the activity of the protoplasm itself. Plants are organisms

which obtain all their food in either the liquid or gaseous form by osmosis (diffusion)." Immediately he finds that there are certain facts which appear to invalidate these conclusions. The myxomycetes at one stage of their lives take solid particles of food very much like the amœbæ, but no other plants are known to do so, and may not there be a connecting link? The tapeworm in the intestine does not apparently take up any solid food, but is nourished by absorption; but this is an exception induced by a parasitical life, as near relatives of the tapeworm take up solid food. The definitions are not, however, proposed as a fixed theory, but as a speculation suggesting lines of research that appear promising.

NOTES.

THE economic value of fossils, says State Geologist Charles R. Keyes in his report on the Palæontology of Missouri, is commonly entirely overlooked. To the laity usually these remains of life are merely curious; to the specialist the interest in the ancient organisms is largely scientific. But with him who wills it even a slight acquaintance with the true character of fossils enables the rocks to be read as a printed page. It is one of the best established facts in modern geological science that an intimate relation exists between mineral deposits and the surrounding rocks; hence the geological age of the particular beds becomes an important factor in the early attempts to develop new mineral districts. This suggestion, again, rests on one of the cardinal principles of geology: that the geological succession of strata is determinable readily by the remains of life contained. Thus, in reality, fossils are labels on the rocks, telling man at a glance the age of the bed he is working, and providing him with the most reliable guides he could possibly secure to direct him to the layers most likely to contain the mineral sought.

COLGATE UNIVERSITY, with three departments leading to degrees in arts, philosophy, and science, and offering a total of one hundred and twenty-five courses of instruction, has adopted the pplicy of requiring the master's degree to be earned by graduate work. The old plan will cease after 1896.

THE summer course in botany of the Torrey Botanical Club and the College of Pharmacy of New York was opened in the College of Pharmacy, March 27th. It is to include fourteen lectures by Dr. Smith Eli Jelliffe, given on Wednesdays, with excursions for study in the field and the collection of specimens. The lectures during May and June will be on the stem, leaves, inflorescence, and parts of the flower, general conclusions, history, and herborization. Besides the lectures, Dr. Jelliffe is giving a course of lessons on Thursday evenings in Vegetable Histology, or the microscopic anatomy of plants.

A CURIOUS instance of the formation of snow was witnessed at Agen, France, on the night of the 30th of January. A fire broke out in a sawmill when the temperature was ten degrees centigrade below the freezing point. The water thrown upon it was instantly vaporized, and, rising into the cold, dry air, was immediately condensed and fell as snow. What with bright starlight and a strong northwest wind blowing, the whirling snow above and the raging fire below, a brilliant spectacle was presented.

A SEVERE storm in England in December last was marked by the deposition of notable quantities of salt on the trees, the ground, and various objects at considerable distances from the coast. Similar phenomena have been observed rarely before. Mr. G. Symons has shown in the Monthly Meteorological Magazine that the spray of the ocean was carried to distances of between seventy-five and one hundred miles from the sea.

AT the Los Angeles Public Library, California, the copies of magazines not needed for binding are filed away, some to replace worn-out circulating copies, while others are taken apart, the illustrations are cut out, sorted, and mounted on gray Bristol board, forming collections of pictures for teaching geography, history, literature, and mythology, besides being samples of the modern school of illustrators and artists. The articles are sorted into classified groups, which are sewed together, some for school, some for library use, some for the hospitals, etc. The comic pictures and advertising pages are sent to the social settlements and to kindergartens for scrapbooks. "For all-around usefulness, attractiveness, and satisfaction," the librarian says in her report, "the magazines which are duplicated for home use are unsurpassed. There is no trouble in securing volunteers for the cutting of pictures, for collectors of material will gladly exchange work for pictures. The report of the teachers on the use of this material in the schoolroom is a general cry for more."

AN experience of the observers at the meteorological station on the summit of Ben Nevis, Scotland, is cited as bearing upon the question of the value of high-level residence in the treatment of tuberculous conditions. These observers are changed every three months. While on duty at the observatory, with all the exposure to extremes of weather to which they are subjected, they

are remarkably free from all kinds of ailments. This has been the case during eleven years. The subsequent residence at a lower level renders them liable to a kind of influenzal catarrh.

THE great exposition to be held in Paris in 1900 is to be much like the two which have preceded it; but a new and special feature will be added. It is intended to make it a sort of a mirror of the century of which it will mark the close.

THE industrial exhibitions now so common are wittily characterized by the Count Alphonse de Calonna, in the Revue des Deux Mondes, as festivals of which industry is only a pretext and amusement has become the real object. "The great capitals and even the secondary cities take turns in dancing a grand six months' saraband around a shrine in which the product of the mental and material efforts of a decade has been piled up."

THE Austro-German Alpine Club includes two hundred and fourteen local sections and more than thirty-one thousand registered members. Its purpose is to improve the roads of the Alps and increase knowledge of the mountains. An exhibition of remarkable maps was given at the general meeting in August, 1894, among them a relief map of the Jungfrau group, on a scale of 1 to 100,000.

CONCERNING the possibilities of the molecular constitution of argon and its chemical position, Prof. Mendeléef finds that if it be monatomic, with an atomic weight of 40, as found by Lord Rayleigh and Prof. Ramsay, it has no place in the periodic system. If it be diatomic, with a molecular formula A_2, its atomic weight would be about 20, and its place would be in the eighth group of the second series, or after fluorine. If the molecule contains three atoms, the atomic weight of argon would be about 14, and it might be regarded as condensed nitrogen; and much may be said in favor of the hypothesis. If its molecule contains four or five atoms, its atomic weight would be 10 or 8, and there would be no room for it in the periodic system. If its molecule be found to contain six atoms, and its atomic weight to be 6·5, it would be placed in the first series, and probably in the fifth group. This, or the supposition that argon is condensed nitrogen, seems to Prof. Mendeléef most probable.

WHILE the employment of anæsthetics has made only slow progress in veterinary practice, a considerable number of the English veterinary surgeons resort to them on all possible occasions, and find them of great advantage. Some operations on horses could not be attempted with any successful result without their aid. Of all animals, the horse is the one to which chloroform can be most safely administered; it is even very hard to injure him with it. Some surgeons, however, use it diluted with air. Attention is now increasingly directed to this matter. An improved apparatus to be used in connection with the administration of it has been devised by Mr. Wallis Hoare, of Cork, by the aid of which the treatment is made more convenient and even safer than before.

M. BERTHELOT has found that argon, under the influence of the silent electric discharge, combines with several organic compounds, and notably with benzene.

A CURIOUS report has been made to the Medico-chirurgical Society of Bristol, England, of operations performed in the Zoölogical Garden. Among them were the removal of an ingrowing nail on a lion, a Cæsarean operation on a gazelle, and gastrotomy on an ostrich which had feasted too heartily on indigestible food, having swallowed a handkerchief, pebbles, a pencil, a portfolio, and a prayer book. The unfortunate fowl died.

A SOCIETY has been formed in Berlin for the purpose of preventing the extermination of the elephant in the German African possessions and of promoting the increase and usefulness of the animals.

OBITUARY NOTES.

GENERAL JOHN NEWTON, a distinguished officer, Chief of Engineers of the United States Army, and an eminent engineer, best known, perhaps, from his services in clearing the channel of Hell Gate from its dangerous rocks, died at his home in this city, May 1st, after an illness of a few weeks, from chronic rheumatism. A portrait of him and a sketch of his life up to his appointment as Commissioner of Public Works of the City of New York were given in The Popular Science Monthly for October, 1886. A detailed account, with maps and illustrations, of the improvement of the East River and Hell Gate, furnished by him, was published in the Monthly for February, 1886. His appointment as Superintendent of Public Works of this city was an ideal one, of the fittest man for that highly responsible position to be found. In it he executed some of the most important works the city has undertaken, and his administration is described as having been notably able and having resulted in great public good. Since April, 1888, he had been President of the Panama Railway Company, the Panama Steamship Company, and the Columbian Steamship Line.

DR. GEORGE A. REX, of Philadelphia, whose sudden death was recently announced, was an earnest student of the lower orders of fungi, an authority of the highest repute on myxomycetes, an ardent microscopist, and a discoverer of many new species in his special province.